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Part I

GENERAL OPERATIVE CONSIDERATIONS

Part II

SURGERY OF THE HEAD AND NECK AND PLASTIC SURGERY

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MODERN SURGICAL TECHNIC

BY

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VOLUME ONE
GENERAL OPERATIVE CONSIDERATIONS
SURGERY OF THE HEAD AND NECK
AND PLASTIC SURGERY

VOLUME TWO
SURGERY OF NERVES, VESSELS, BONES
SURGERY OF BREAST AND CHEST

VOLUME THREE
ABDOMINAL SURGERY
HERNIA
GENITO-URINARY AND GYNECOLOGIC SURGERY

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TO AN INEXHAUSTIBLE SOURCE OF CONSTANT INSPIRATION

MY WIFE

AND

MY SON DR. PHIL THOREK

This volume is affectionately dedicated by the Author

FOREWORD

The remarkable advances in the scope and quality of surgery during the past fifty years have been studied from many different viewpoints The scope of surgery has been enormously expanded by remarkable results effected in established as well as in new fields, by scientific and safe approach to every part of the body, by the willingness to discard apparently well-established major surgical procedures for simpler methods and by the consequent great and rapid increase in the number of practicing surgeons During this period, surgery also can be credited with giving impetus to clinical and laboratory methods of identifying lesions in early stages of their evolution and with the attempt to control ameliorate abort and prevent those conditions which are known to be dependent on disturbed physiologic processes so that in all surgical fields the approach to sound surgical treatment is more and more made through research being carried out in clinical and experimental laboratories The factors contributing to these great advances in surgery therefore have come from every field of medicine and have been applied chiefly in stressing the basis on which successful treatment may be founded namely, accurate diagnosis.

The necessary application of the great increase in knowledge in the basic sciences particularly in physiology pathology and biochemistry to the practice of surgery and the emphasis which has been given their importance are likely to obscure the fact that surgical results always will be directly dependent upon the technical skill and judgment with which such knowledge is applied. A profound knowledge of fundamental fields without good judgment, technical skill and experience usually means unsatisfactory surgery Further advances in surgery therefore, will depend, to a considerable extent on the capacity of man to improve in such technical pursuits and any contribution which may aid in this advance is important.

When such a contribution has the intent of presenting a general picture of surgical technic in the various fields, it represents a vast undertaking because of the enormous number of surgical procedures which must be evaluated and from which selections must be made so as to give a comprehensive clear, and authoritative picture of the status of modern surgical technic. In this primary purpose this work has succeeded admirably and should be an invaluable reference for all general surgeons and for those who are limiting their surgical practice to particular fields The text and illustrations are designed to facilitate the application of these methods and since the avoidance of errors in technic is often dependent on whether or not the surgeon knows what should be done and how it should be done the volume should be indispensable to those who have the responsibility of the surgery in their communities

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DONALD C. BALFOUR, M.D

PREFACE

There is no lack of excellent treatises covering the field of operative surgery But the available works fall generally, into two categories voluminous systems which, while containing a wealth of material, offer such a multiplicity of procedures as to prove confounding and single volumes which are too abridged to afford detailed information sufficient for the student and general surgeon—a sort of plethora in one, and an obvious deficiency in the other

It is for this reason that the author felt there existed a genuine need for a succinct work on surgical operations, up-to-date as regards important advances in surgical technic and including in order to be practical, a sufficiently detailed description of each procedure in all commonly performed operations The aim of this book is to supply this need It is intended particularly for students for general surgeons and for those general practitioners who are occasionally called upon to perform emergency operations.

There is always a certain feeling of diffidence in presenting a new book to one's professional colleagues. The author's personal experience of over thirty years in the daily practice of general surgery in observing the methods of master surgeons at home and abroad and in teaching surgical technic must be his excuse for presuming to present the surgical profession with a practical book of this kind one which he believes contains the most important facts for those for whom it is intended.

There are those who think that whatever is new is the best. This is not always so. A multitude of standard surgical procedures of today are not new but improvements of cruder methods which had their inception in the mists of antiquity Indeed many old operations are still modern, and in many respects surgeons of today do not excel in, perhaps they do not equal the technic of their predecessors Sentiment and justice demand that we should not forget those who pioneered for us and although no attempt is made to delve thoroughly into the history of surgery yet some historical notes are included and credit given to those who have developed particular surgical procedures.

Surgical technic is no one's prerogative and no man has ever lived who has excelled in every field of surgery Highly technical procedures of an elective type not commonly performed have only been sketched for completeness sake. Emergency operations which any surgeon may have to perform have been included in the general scheme.

I have considered it important to give the high-lights of surgical anatomy preceding operative procedures Unfortunately many text-books of surgical technic of today allot little space to such important subjects as amputations ligation of blood vessels, fractures dislocations, etc., etc. of this I took cognizance and I have included them in this work In describing operations I have adopted the step-by-step method for the benefit of the student and of the inexpert operator to whom methodical procedures are essential until he has become proficient. Some of the operative procedures are original methods, but for the most part they are the standard procedures whose value has been confirmed by time

On the principle that as the Chinese say "one picture is worth a thousand words," extensive illustration has been employed. Not only do illustrations spare

lengthy descriptions, but they give a much clearer idea of what the author intends to convey In this connection, I wish to extend my warmest acknowledgment to Mr W C. Shepard. He is an outstanding artist who has combined his remarkable ability for graphic illustration with his profound knowledge of surgical anatomy in bringing out the salient points pertaining to the various operations.

My sincere thanks and grateful acknowledgments go to the many authors who have kindly granted me permission to reproduce original illustrations, to the authors of treatises from which descriptions of certain standard operations have been borrowed to Dr Harry L Pollock who graciously read the manuscript on surgery of the ear, nose and throat, to Dr Oscar H Nugent for suggestions on surgery of the eye, to Dr Raymond W McNeally from whose contributions on the surgery of the vascular system I have liberally borrowed, and for his critical and painstaking editing of the chapter on vascular surgery and to Dr Donald L. Dickerson for some of the sketches made from life and for proof reading parts of the manuscript to Misses Angela Bartenbach and Hebilly Magda West for supplementary illustrations, to Dr Horace E. Turner for careful proofreading and suggestions in the chapter on Orthopedics, to Miss Leona Tanner for the careful typing of the manuscript—a nerve-taxing task, to Miss Marie Berger for a number of line and wash sketches throughout the text, as well as to Dr Captola Rutter for careful proofreading.

Lastly special gratitude is expressed to the publishers for their unfailing courtesy, untiring and boundless cooperation regardless of expense, invaluable advice and general help in the production of this book

If this work meets with the same kind reception as did my last, 'Surgical Errors and Safeguards" the forgone vacations and the intensive effort which has been put forth in the years just passed to accomplish this task will appear infinitesimal as compared with the gratification of the author

MAX THOREK

The American Hospital of Chicago

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being a brilliant operator as the highest attainable honor. The surgeon should be an artist, not a manipulator. It is high time that the fact should be recognized that any one cannot improvise himself a surgeon, and that it does not suffice, in order to constitute an operator, to be able to manipulate some dozens of hemostatic forceps more or less adroitly.

The name of "surgeon" is merited only by one who is a profound and accomplished clinician and at the same time a prudent and skillful operator.

At the present time the increase of surgical operative work by general practitioners, owing to the increased facilities afforded by the many small hospitals throughout the country, tends to make ambitious young men undertake major surgical operations for which neither their training, experience nor resources render them fit. I do not refer to emergency surgery, which must be done even in the face of known risks, but to elective surgery, which should be done only by the competent. As Kocher says: "The more surgery has become the common property of medical men the more it is incumbent upon any one who intends to devote himself to the practice of surgery to take every opportunity of improving his technique."

The medical profession justly complains that unwarranted operations are often undertaken by men of little experience. Unfortunately warranted operations are also often undertaken by men of the same type.

What steps are necessary, therefore, in order that one should merit the dignified title of surgeon? First, a long apprenticeship under masters of the surgical art in order to obtain a profound knowledge not alone of diagnosis but also of the indications for any operative procedure. Second, a thorough knowledge of anatomical structures, and physiological functions, with special reference to the manner in which these may be affected by surgical operative manipulations. Third, in so far as possible, a skilled technic in the actual performance of operations not only on the cadaver but on the living subject; and one must know every detail in the management of these cases in the pre- and postoperative phases under normal and abnormal circumstances. Fourth, understanding of the constitution of different types of patients, to be able to decide on operability and on the best time to operate as well as on the best type of operation for a given case. As Watson truly says:

"For every operation there is really only one good method and the surgeon must act according to the findings, as his experience and judgment will lead and he must perform his work simply and well. Every surgeon worthy of the name should not only be conscious of his capacity and aptitude but be more particularly conscious of his limitations so that he is really fit to perform, but be capable of undertaking and performing for the ultimate cure of his patient."

While the ultimate cure of the patient is always the prime object of surgical interference, the preservation of physiologic function, if at all possible, is also an essential. A good surgeon, while always ready to perform heroic surgery if actually demanded, will refrain as long as possible from removing or rendering useless any limb or organ and in every operative procedure there must be method. Every extirpation, resection or reconstructive operation must be planned and executed on strictly anatomical and physiological laws.

When we consider the seriousness of a major surgical operation, the necessity for painstaking examination and clinical observation of a patient by the

surgeon before he arrives at a definite diagnosis is at once seen. Today diagnostic procedures are better than at any period of surgical history. Yet, if the of surgical commissions based on hasty and erroneous diagnoses are recorded anywhere, there must be a very large number of such records.

Lastly as regards technic it is a matter of constant practice. Manual dexterity is not picked up from books or by observing others. Knowledge of the best methods of doing any kind of surgical work is acquired only by experience and by keeping one's self acquainted with new methods as they appear and practicing them. Practice alone makes perfect but there is no use in being perfect in what itself is faulty. Technic distinguishes the surgical artist from the mere manipulator.

Taking into consideration the surgeon as a whole, Lord Moynihan aptly said, "He must have an eagle's eye, a lady's hand and a lion's heart," to which I would add a personality that inspires hope and confidence. His attitude towards his patients must be one of sympathy and gentle consideration with an ever watchful solicitude for their care and safety.

CHAPTER 2

THE SURGEON AND THE PATIENT

"One essential matter is that he (the observer) must have seen the patient and elicited the symptoms from the patient. He must have watched the patient and noted the progress of the disease and the circumstances that accompany its progress, and have correlated the signs during life with those found at operation or death."—*Sir James Mackenzie.*

In an emergency surgical operation there is, of course, no time for study but in most other conditions there is sufficient time before operation for the surgeon to become more or less thoroughly acquainted with his patient. If possible, every surgical operation should be preceded by a period of complete physical and mental rest during which the constitutional peculiarities and the resistance power of the patient should be noted.

The surgeon can learn a good deal from the patient at his preliminary interview. The trained eye may frequently observe constitutional and other peculiarities, but it is only after complete history taking and diagnostic procedures that a definite decision can be reached as to the true nature of the patient's trouble and as to the necessity for a surgical operation, as well as to the patient's capacity to undergo such operation as may be decided upon. There should be no failure as regards carelessness or want of thoroughness in respect to the preoperative investigation of a patient. The diagnostic paraphernalia is now vastly extended and all essential and unusual facts can be recorded and correlated with symptoms.

HISTORY TAKING

The complete history taking of the patient comprises many subdivisions and entails much care. Such important work should never be delegated to nurses or other subordinates; it demands the careful attention of the surgeon himself. He must personally verify the findings of the particular complaint to which the patient has called attention.

A patient was referred to me with a diagnosis of a possible malignancy of the descending colon (loss of weight, pain in the left colon region and somewhat suggestive x-ray findings). Pain was elicited while examining the patient's abdomen and palpating the left colon. During the course of the examination, I discovered the man was wearing a suspensory bandage. He said that he occasionally had a dragging sensation in the left testicle. Upon inspection after removal of the suspensory bandage, it was discovered that the man had a malignancy of the testicle and that the pains along the left colon were in all probability due to retroperitoneal metastases from the testicular tumor.

The simplest complete record of every patient operated upon should contain:

1. A concisely written statement of the condition of the patient, his history as stated and elicited.
2. A short orderly account of a general systematic examination noting particularly any abnormal findings.
3. The diagnosis, tentative or otherwise.
4. A short note on the treatment and an epitome of the surgical operation and findings disclosed.
5. Reference to any complications.
6. A note of the final results.

As regards the examination, the heart, lungs and kidneys should always be investigated with special care, no matter what the nature of the surgical procedure ought to be. In operations on any part of the intestinal tract, the mouth and teeth should receive special care and all foci of infection should be removed to obviate postoperative parotitis and postoperative pneumonia. Matters which should interest the surgeon are any tendency to hemophilia or to acidosis, obesity, alcoholism and constitutional peculiarities.

PREOPERATIVE CARE

Patients are admitted to the hospital for elective operations at least by 3 o'clock on the afternoon of the day preceding the operation. Whenever possible the patient should be observed for a day or two prior to the operation. On admission the patient is given a tub bath. The presence of skin eruptions or anything unnatural about the patient is reported by the nurse to her superior.

A preoperative diet should furnish a high percentage of nutritive value in small bulk, should be readily and rapidly assimilated and should leave a minimum amount of intestinal residue. The diet on the day or two preceding an operation should be light. After midnight preceding the morning of the operation foods are restricted or withheld unless specifically ordered otherwise.

In emergency operations, if food has been taken within six hours of operation, the stomach should be emptied before operation by lavage with plain warm water or with the addition of a small amount of sodium bicarbonate.

Catharsis. As a general rule it is considered unwise to disturb a patient's rest on the night before operation by giving him cathartics. Normal intestinal movements and functions are disturbed and it is possible that there may be an increase in absorption of intestinal toxins and a greater permeability of the intestine to bacteria. A mild purgative may, however, be given.

In the average case no special preparation is needed prior to the afternoon of the day preceding operation. A tub bath is given then and the entire field of operation cleansed thoroughly with green soap and water. The umbilical pit receives particular attention if it will be in the field of operation.

The entire field of operation is shaved. In abdominal operations this includes up to the nipple line and posteriorly to the midaxillary line; the entire pubic region is thoroughly shaved. It is important that this area be shaved cleanly so that the finest hairs are removed. To neglect this invites skin infections. Avoid injuring the skin with the razor. In gynecologic operations, it is well to do a complete vaginal preparation, unless contraindicated (virgo intacta). In hernia operations, the scrotum and contiguous areas are also surgically prepared.

After shaving, the entire abdomen is scrubbed thoroughly with green soap and water for three minutes; the field is now dried and treated with ether and 70 per cent alcohol. A sterile towel is placed over the field and kept in place with adhesive strips.

Unless there is some specific reason, all patients to whom an anesthetic is given receive a hypodermic injection of one-fourth grain of morphine sulphate with [illegible] grain of atropine sulphate three-quarters of an hour before going to surgery. After the injection has been given, the patient is kept quiet.

The patient's hair must be in order and free from hairpins. False teeth must be removed. The patient's bladder should be emptied and a record of the quantity of urine before the operation made; the large bowel is emptied by enema. If the patient does not void the interne or surgeon must be notified. If necessary, the patient should be catheterized. The patient should don a fresh gown and leggings. He or she is not to receive visitors and should be left in a

FIG. After thorough preparation, the navel or the umbilical pit is sealed with collodion, as shown in this illustration.

darkened, quiet room after the hypodermic injection is given. In all elective abdominal operations and where not contraindicated, I administer routinely before the operation an ampule of pitocin. It has served me well.

No patient is admitted to the operating room unless accompanied by a complete history and physical examination, complete blood, urine and other special analyses, or if no preoperative diagnosis is recorded on the chart.

The patient is brought to surgery twenty minutes before operating schedule time and placed in proper position on the operating table. After the patient has been anesthetized, the entire field of operation and abdomen is exposed by removing the sterile towel. With a sterile sponge on a forceps the entire area is gone over with ether. In case of the abdomen, the ether is permitted to drop into the umbilical pit but the sponge is never allowed to touch it. With this sponge, first cleanse over the site of the proposed incision. Always work away from the proposed line of incision until the entire field is cleansed. Discard the sponge. With a fresh sponge cleanse the umbilicus and then discard

the sponge used. Following the preparation with ether, the same procedure is repeated with 3½ per cent iodine solution and again a final preparation with 70 per cent alcohol.

Carefully remove all iodine, thus preventing burns. Seal the umbilical pit with collodion (Fig.). Drape the patient with a heavy sterile towel and remove him or her to the operating room for final draping.

Male herniotomy patients are subjected to a complete scrotal and penile preparation with tincture of merthiolate ... area (Fig. 99).

MENTAL ATTITUDE OF PATIENT AND SURGEON

It is most desirable that the patient should go to surgery in as calm a state of mind as possible. Newer methods of preparing a patient include preanesthetic medication so that the patient is in a semi-conscious state before being anesthetized. This will be fully discussed in the chapter on General Anesthesia, page 34.

Every surgeon has observed that the cheerful, optimistic type of patient makes good progress while the nervous, overwrought, worried and depressed one fails to make headway. Crile has pointed out that fear and apprehension lead to exhaustion of the bodily reserve and deplete the adrenal reserve. The only preventive is to try, before the operation, and after it, to calm the nervous patient in every possible way and to induce him to take a cheerful outlook. All suggestive influences which tend to raise the patient's spirits and remove dread and fear are warranted even though the outlook is grave. Surgeons and their personnel should never betray any form of anxiety or apprehension in the presence of the patient, or by their actions or phrases lead him to suspect that *he is facing a serious crisis. Even life-saving measures should so far as possible be done in a* matter-of-fact way as if they were routine.

No patient who shows an apathetic, fatalistic attitude towards an operation should be operated upon while in that frame of mind. My personal experience has been that a patient who is convinced that he will not recover from an operation or does not wish to recover not infrequently has his wish fulfilled. I have, therefore, made it a practice to try to change such a mental attitude of the patient. A hopeful, confident frame of mind is frequently a most important factor toward favorable surgical prognosis.

The mental attitude of the patient very often depends on the mental attitude of the surgeon and plays a most important rôle from many points of view. Cheerful surroundings, a cheerful surgeon, a pleasant nursing staff and a form of suggestive therapy accomplished by the conduct of the surgeon are essentials for success. Personally if I were ill, I would not permit a surgeon whose demeanor recalls the mortuary or the undertaker to minister to my physical needs. Apprehensive patients gain much, though they be seriously ill, by the warranted optimism suggested by the surgeon. Of course the relatives of the patient should at all times know the truth of the existing condition.

Two young women were scheduled to be operated on by the author for simple "interval" removal of the appendix. They occupied adjoining beds. Both were in splendid condition except that one of the patients, a young woman of nineteen, made the statement to the nurse that "she feels confident that she will

never leave the hospital alive." This form of comment she indulged in rather frequently. It was, however, not looked upon by the attendants as a matter of importance. Both patients were operated on in the same forenoon. There were no complications or difficulties of any sort during the operative procedure. Both were returned to bed in excellent condition. The first post-operative day nothing unusual was observed. On the second day the patient referred to began to have visual hallucinations of "churches, funerals," "passing her mother in heaven," etc. She sang and muttered almost incessantly about the angels in the skies, etc. Her general physical condition was excellent. On the third day sedatives were used. On the fourth day during an attack of violent temper she tore her dressings off, became almost unmanageable and had to be restrained. The visual hallucinations became worse and with all measures at command to alleviate the condition it was all in vain. Death ensued on the eighth day following a "simple appendectomy." A remarkable sidelight of the case is that the second patient, referred to above, occupying the next bed, seeing the delusions of her friend with whom she had been discussing religious topics prior to the operation, went into a cataleptic state which lasted about two days, from which state she finally emerged following sedation, suggestion, etc. Thus, it is wise not to operate on a patient whose mind is set, at the outset, that he or she will not recover. An attempt is made to dissuade the individual and convince them, by every means possible (continued suggestion) that a hopeful attitude is justified and that there surely is no need for apprehension. In predisposed individuals the psychic trauma may precipitate an acute mental upset.

In the postoperative period constant watchfulness of the patient by the surgeon himself is as important as the technical operation per se and as much a part of the surgeon's personal duty as is the operation. His experience will enable him to observe the first symptoms of any approaching complication which, in many instances, he may be able to avert. The surgeon's neglect of the aftermath may end in fatality.

CHAPTER 5

POSTOPERATIVE CONSIDERATIONS

IMMEDIATE SEQUELAE

In every major operation, especially those involving vital organs, all or some of certain sequelae may eventuate in a greater or lesser degree. These are shock, hemorrhage, infection, obstruction and embolism. With clean aseptic surgery, regard for hemostasis, gentle manipulations and careful preparation of the patient, these may be reduced to a minimum and clinical manifestations may be very slight, but some degree of shock and pain may always be expected.

SHOCK

Shock is the result of many causes. The best definition is perhaps that it is a reflex depression of the vital functions owing to bodily injury, either traumatic or operative. The one constant finding in shock is the persistently low blood pressure. The symptoms of internal hemorrhage may be confused with those of shock, but while shock may be present without hemorrhage, considerable hemorrhage is always accompanied by some shock. In shock from any cause should the systolic blood pressure register 90 mm. of mercury or less, restorative measures are immediately called for: oxygen, glucose and sodium bicarbonate, external and internal heat, blood transfusion, etc. Transfusion is the specific remedy for shock due to hemorrhage. The fall in blood pressure may be temporarily combated by intravenous infusions of saline.

The operative prophylaxis of surgical shock is provided for by Crile in the special technic which he devised and named anoci-association—a technic which can be utilized to advantage in most major operations. It minimizes physical and psychic factors concerned in the production of operative shock and at the same time attempts to reduce postoperative pain and discomfort. The idea is to prevent harmful or painful impulses reaching the central nervous system following irritation of the sensory nerves, whether owing to division or to pull upon the various sensory nerves that may be involved in the area of the operation. The essential step in Crile's method is to block the nerves supplying the operative field by regional or infiltration analgesia using a solution of ¼ to [illegible] per cent novocaine to which adrenalin is added.

When a patient who has been subjected to a long and exhausting operation is returned to his bed, external heat should be applied (not by means of hot water bottles) under careful supervision, and such other restoratives as may be indicated.

In so far as they may be considered nervous phenomena, postoperative vomiting and hiccough are partly the result of shock.

Vomiting, of course, is also associated with the after-results of anesthesia. The important point in connection with excessive postoperative vomiting the patient may become so weak that he is unable to expel the vomitus.

may be drawn into the larynx or sucked into the lung by inspiration causing operative pneumonia. If no mechanical means suffice to bring up the vomitus, resort to gastric lavage or Levine tube aspiration (Fig.). Generally when postoperative vomiting persists for six hours (or for shorter period if copious)

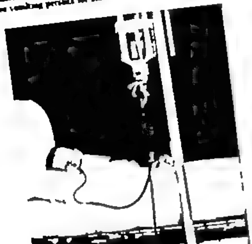


Fig. . Wangensteen suction with Levine tube in patient with cycle 4 hours of the stomach following ... Intravenous saline transfusion. Recovery. (Author's Surgical Service Cook County Hospital.)

the condition should be met by gastric lavage with hot water to which drams of sodium bicarbonate has been added to the quart of water the stomach is filled and then the fluid siphoned off several times.

Hiccough is most frequently observed after upper abdominal operations.

It is said to be due to an irregular spasmodic contraction of the diaphragm caused by irritation of the parasympathetic nerve. It probably one of the effects of surgical shock. There are no known certain means of relief, but among those that are commonly practiced, compression of the diaphragm one of the best.

Before leaving the subject of operative shock it may be reiterated that such of extra vigorous surgery such as the rough use of retractors, the picking up of small vessels with powerful clamps, the roughness of unnecessary haste the forceful and harmful use of swabs and packs should be entirely dispensed with. Such practices devitalize and impair the power of repair of the tissues. The maintenance of gentle and careful technic not only minimizes shock, but makes all the difference between good and bad operative results.

HEMORRHAGE

The surgeon should carefully examine all bleeding points before terminating an operation. oozing is best controlled by gauze packs wrung out of hot saline solution. larger vessels should be located and ligated. It superfluous to reiterate that during an operation the operative field should be kept as bloodless as possible. The surgeon will soon learn that he can control hemorrhage in the vast majority of cases by good light and exposure of the part and prompt action. There should be no excitement in the presence of copious hemorrhage. The necessary steps must be undertaken with calmness, method and expedition. The more pronounced the surgeon's sang froid under such circumstances, the better.

Postoperative hemorrhage may become manifest up to the fifth or sixth day following operation and even much later. It is owing to erosion of blood vessel, to the spread of infection or to the pressure of drainage tube or tight pack. The detachment of clots, slipping of ligatures and cutting through of blood vessels usually give rise to postoperative bleeding. The only treatment is to expose the blood vessel promptly and control hemorrhage. If the loss of blood is severe restorative measures will be called for as well.

INFECTION

Even with the most rigorous aseptic technic no surgeon can feel absolutely sure that postoperative infection in some degree will not appear. Sometimes operative wounds show signs of slight infection along the suture line the so-called stitch abscess, manifested by redness, swelling and pain with rise in temperature. If small and localized, one or two sutures may be removed and hot moist antiseptic dressing applied. But if more extensive the wound may require opening up and the insertion of small drain tube. Stitch abscesses may perhaps, be best avoided by observing meticulous asepsis, avoiding dead spaces, approximation without strangulation and careful hemostasis. It is asserted that positive cultures of infective microorganisms can be obtained in over 50 per cent of fresh surgical wounds. The phagocytic powers of the tissues can, however dispose of most of these. The surgical field may become infected in the course of an operation when hollow lumen is opened. In such cases drainage is imperative.

POSTOPERATIVE CARE AND LATE COMPLICATIONS

The surgical operation is only one phase in the treatment of some definite disease and if the surgeon has undertaken the complete treatment of the patient his responsibility does not end with the operation but continues until the patient is finally discharged as recovered. The postoperative care of patient must not be indiscriminately left to subordinates many complications may arise and in this period the surgeon must prove himself also physician, and the early recognition of the signs of impending complications may be detected by his experienced eye rather than be left to the observation of those with less mature judgment.

The number of complications which may follow an direct or indirect result of surgical operations is very large depending upon the constitution of the patient, his preoperative condition, the type of operation and unforeseen accidents. An incomplete list of such complications includes postoperative backache, gastric dilatation, intestinal distention and obstruction, postoperative hiccough and pneumonia, thrombophlebitis, pylephlebitis, pulmonary infarction and embolism, urinary retention, renal complications, acidosis, parotitis, postoperative paralytic intestinal obstruction, etc.

While any one or more of these may occur as sequel to an otherwise carefully executed operation, yet it would not be good surgical judgment unduly to alarm patient by informing him of their possibility as the chances are greatly in favor of no serious complication occurring.

Vigilance, constant vigilance, is the proper attitude of the surgeon until the period in which the development of complication might occur has passed. The modern practice of thorough preoperative preparation of the patient, when the operation an elective one has obviated many of the possible complications, but some still strike like bolt from the blue.

Some of the first considerations that will arise in the immediate postoperative period are those of thirst, catharsis, nutrition and postoperative pain.

THIRST

If the patient can drink and there no contra indication inherent in the type of operation water may be given if the patient desires. Preferably the water should be hot, not lukewarm, with little bicarbonate of soda added or weak tea may be given. Ice sucking is not desirable since tends to increase the thirst. Proctoclysis is, however the best method of relieving thirst. The rate of flow should be about 6 ounces per hour for rectal absorption. Continuous subcutaneous absorption (hypodermoclysis) (Fig. 2) may also be employed using freshly distilled sterile water heated to 100° or F. There is considerable loss of body fluids following anesthesia and during operation which, coupled with the fact that the postoperative intake of fluid is much limited for some makes it very necessary that the patient's tissues should obtain fluid by some other means. (Fig.)

CATHARSIS

While postoperative catharsis should be avoided as far as possible, yet the surgeon should carefully watch the postoperative action of the bowels and re-

lieve them of necessary by other means. In the average case disturbance of the normal action of bowel movement, which may have been quite regular previously, may on account of the general organic upset consequent upon operation, last one or two days until the organism has regained its equilibrium. If the general improvement in the patient is satisfactory simple enema after the second day will add to the patient's comfort. If however function is delayed, following prolonged surgical manipulation or other cause then saline ... must be assisted by medication. Calomel or saline cathartic may be used.

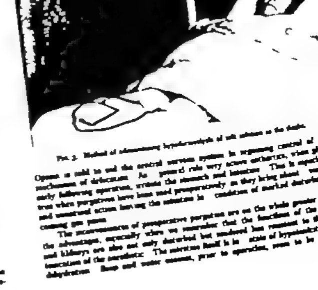


Fig. 2. Method of administering hypodermoclysis of salt solution in the thighs.

Opium is said to aid the central nervous system in regaining control of the mechanism of defecation. As general rule very active cathartics, when given early following operation, irritate the stomach and intestines. This is especially true when purgatives have been used preoperatively as they bring about marked and unnatural action leaving the intestine in condition of marked disturbance causing gas pains.

The inconveniences of preoperative purgation are on the whole greater than the advantages, especially when we remember that the functions of the liver and kidneys are also not only disturbed but rendered less resistant to the intoxication of the anesthetic. The intestine itself is in state of hypotonicity and dehydration. Soap and water enemas, prior to operation, seem to be better

[illegible]

Fig. [illegible]

DIET

[illegible]

POSTOPERATIVE PAIN

[illegible]

CHAPTER 4

OPERATING PAVILIONS AND THE OPERATION IN GENERAL

OPERATING PAVILIONS

[illegible]

[illegible]

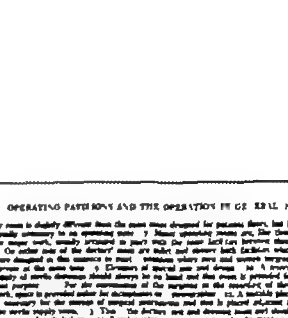


Fig. [illegible]

[illegible]

building which would have at least twelve stories. Above this floor there may be arranged a gallery for medical students so that all operating rooms may be visible from above. In this sketch the gallery extends down into one major operating room so as to bring observers close to the field of operation.

The foyer or general lobby for the surgical floor. 2. Four general operating rooms are shown, one of which has the gallery extending into it. 3. Cystoscopic and orthopedic operating rooms with water and instrument sterilizers between. 4 and 5. Also scrub-up sinks for doctors and nurses. 6. Utility room for the major surgical section and another for the minor surgical section. 7. The surgical floor is designed so as to separate the minor and major sections as far as possible and the various minor operating rooms here can be used for surgical dressings, infected cases or other purposes. 8. Toilet, shower bath and locker rooms for male and female surgeons adjoining the doctors' lounging and dressing room. 9. There are four elevators intended for the entire building but only two of them, as shown, extend up to this floor and, when the surgical floor is in operation these two elevators may be reserved for

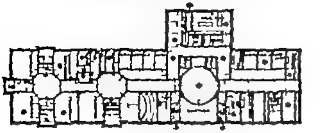


Fig. 6. Surgical section of a hospital of [illegible] beds.

that surgical use. These elevators open into the service hall for patients and also into the main foyer for doctors, nurses, visitors and students. 10. Station for nursing supervisor in charge of traffic and communications, especially equipped with telephone connection and signals. Cubicles for the convenience of surgeons in dictating surgical notes either to a clerk or into a dictaphone to be transcribed in the clinical record office. These are a part of the surgeons' lounge. 12. Surgical instrument room. 13. The surgeons' lounging and dressing room. 14. Space for supplementary [illegible] adjoining orthopedic, urological and gynecological operating rooms. 15. Four separate compartments within a sub-corridor for anesthetizing. 16. Small laboratory for emergency and tissue examinations. 17. Nurses' workroom for the preparation of all surgical dressings which are sterilized in autoclaves and stored in it until required in the operating rooms or elsewhere in the hospital. 18. [illegible] beds already sterilized and cleaned to prevent surgical cases from passing through the main foyer. 19. The plaster room for the storing and preparation of dressings for orthopedic cases, adjoining the operating room intended for this specialty. Toilet and wash room for female nurses. 21. Autoclaves for the sterilization of dressings which are prepared and inserted from the nurses' workroom and removed on the other side into the room intended for their storage and distribution.

In hospitals of 50 beds or thereabouts, it is rarely possible to provide space for more than one room for operative surgery. Correlated facilities must needs

be curtailed here. In every instance, however, it is absolutely essential to provide a surgeons' scrub-up sink, the necessary equipment for the sterilization of instruments, water and dressings. These are preferably to be located outside of the operating room. However small the hospital, a nurses' workroom is an indispensable necessity. Here dressings are prepared for sterilization, the various solutions made, surgical trays set up, etc. In very small hospitals, this room will not only supply the needs of the operating room but will serve for other surgical functions.

No matter how small a hospital is, a dressing room for the surgeon is a necessity. It should be located close to the operating room. Wherever possible, shower and toilet facilities should be provided.

Where only one operating room must be used for all classes of surgical operations, the need for sanitation and cleaning the room is imperative, particularly if being used for pus cases. Such hospitals should have in the operating room, tile walls and floors with suitable drain in the floor to facilitate complete cleaning at frequent intervals.

There is a tendency in the small hospital, because of limited personnel, to locate the delivery room either immediately adjoining the operating room or closely adjacent thereto. As far as practical, this tendency should be discouraged because of the danger of cross infection. Thus wherever possible the delivery room should be located on a different floor from the operating room and the operating room supervisor should not function in both places.

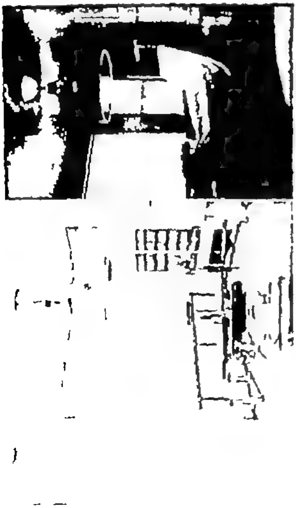
THE OPERATING ROOM

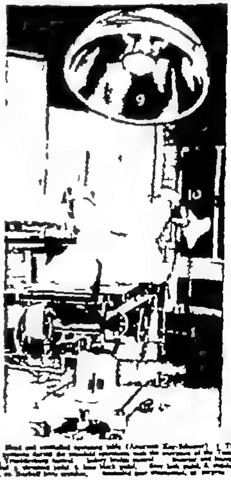
Every surgeon has his own pet idea about the "ideal operating room." Some wish the walls of their operating rooms painted gray, others green and still others black. My own preference is for white. It urges a scheme for cleanliness and is in harmony with the spirit of the activities (Fig. 7). The important general principle agreed upon by all surgeons are

ILLUMINATION

Good Light. Too much fuss is made about where the windows should be placed. Is it not a fact that most of us operate by some sort of artificial light, no matter how bright the sun may be shining? It is not the high cost or complicated construction of the apparatus that matters but how efficient a source of light it is. It should be remembered that no matter how fine an electric illuminating equipment may be, provision should be made for an accessory (emergency) source of light in case the former ceases to function. Gas or a battery light may be resorted to.

The most important requirement for an efficient operating room light is that a maximum of light with a minimum of heat. This is obtained from the American Luminaire (Fig. 8). The degree of light is under absolute control and may be adjusted to the visual requirements of the surgeon for either superficial or deep light penetration since it has a range of zero to [illegible] foot candle intensity. It is practically shadowless and permits the surgeon to operate with comfort. Its optical system eliminates glare.





VENTILATION

Above all, the patient must be protected from draughts; many postoperative pneumonias result from disregard of this precaution. In abdominal operations particularly, the temperature should be warm (between 70° and 75° F.) yet well ventilated.

EFFICIENT OPERATING ROOM EQUIPMENT

Operating Table. There are numerous good operating tables at the disposal of the surgeon. A table that promptly responds to the needs of change of

Fig. [illegible] Correct "set-up" for operation. [illegible]

position without disturbing the patient and demoralizing the operating team is of great value. The author derives much comfort from the "Head End" Control Operating Table which permits the anesthetist, without moving from his seat, to control without disturbance and with precision every operating position required by the surgeon (Fig. 9). It is an extremely versatile instrument of precision in meeting emergencies and in obtaining required precise positions so necessary in operative procedures.

The placement of the operating room equipment is best seen in the appended diagram (Fig. 10). I have basins on either side, one for rinsing the hands, the other as a receptacle for soiled sponges and instruments. Dropping these on

the floor is both unsurgical and unesthetic. The assistant has a similar arrangement on the other side.

The position of the patient on the operating table will be discussed when describing the particular operation.

Strict decorum in the operating room should be insisted upon. Loud conversations between assistants and nurses should not be tolerated.

THE OPERATION IN GENERAL

In the actual conduct of any surgical operation, the surgeon of limited experience cannot afford to take any risk but must proceed methodically, step by step, in an orderly manner, not omitting any step in strict surgical and operative technic that established standard procedure has recognized as essential. In the case of an experienced surgeon, who by constant practice has become thoroughly familiar with all technical details, a certain amount of latitude may be allowed in omitting or varying steps in the technic when he is perfectly confident of the end to be attained and the means of reaching it. While time is often the essence of success in surgical work, yet the nicest judgment is required to discriminate between hurry and deliberate, calculated rapidity in doing what is actually necessary. Any surgical operation, especially a major one, is a serious matter for the patient. If it must be done so as to accomplish a definite purpose for which it is justified, then the quicker it can be correctly executed the better.

Clean, deliberate, purposeful, but still rapidly executed, sure work should be the aim of every surgeon; but to boast of being able to do an operation in a very short time merely for the sake of rapidity alone is a confession of surgical weakness. Note the following aphorism:

"There are surgeons who operate upon the 'sudden' principle of surprise attack, and the haste and tumult of passes are terrible to witness. There are they who operate with one eye upon the clock and who judge the beauty of any procedure by the fewness of the minutes it has taken to complete. There are other surgeons who believe in the 'light hand,' who are the sincere protectors, and who deal honestly with every tissue they touch." (Moynihan.)

PERSONNEL

Planned rapidity in execution is greatly enhanced by good team work. A surgeon works best with those who are accustomed to his personal methods and who are perfectly trained to do what is necessary with the least amount of direction from the operating surgeon. Such a personnel in an operating room anticipates every step in the surgical ritual and each is ready to do his or her part at the right moment. They facilitate the conduct of an operation and in an emergency they can be relied upon to act with calmness and judgment.

Assistants, not how many but how well trained, should be the slogan. Some surgeons have too many assistants; others go to the other extreme—like Kilmarnock who picks out his own instruments and threads his own needles. I concur with Eugene St. Jacques who says, "few but well-trained hands are the desideratum."

ASEPTIC TECHNIC

At present surgical technic has evolved into the aseptic method and there are certain general principles governing this method which should be thoroughly

understood by all who attempt either manipulations or cutting operations. It is known that when the edges of a surgically clean wound are carefully coapted and kept at rest prompt healing by first intention will occur unless the wound is invaded by certain species of bacteria (the pyogenic group). When such are present to any extent, inflammatory signs will be manifest which delay and prevent healing. Living tissues possess a natural power of resistance to infection depending on the individual's general resistance and it is part of surgery to strengthen this natural defense as much as possible. Prevention of wound infection further demands that everything used in the performance of an operation must be germ free and that the field of operation should be protected from contamination by the operating personnel who come in contact with the patient. The thoroughness of sterilization, the care exercised by the operating surgeon and his assistants must be to a great extent a matter of surgical conscience and personal responsibility. The care of the surgical armamentarium can be reduced to a routine mechanical process. There are various methods to accomplish this. The method of sterilization of instruments, etc., will be described in a separate chapter on Sterilization (p. 40).

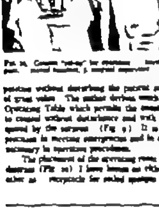


Fig. [illegible] Surgeon after [illegible] [illegible] [illegible] [illegible] The [illegible] [illegible] [illegible] [illegible]

The observance of strict asepsis from the bacteriologic point of view is one of the chief aims in formulating the steps of modern surgical technic. Not only should steps be taken to prevent the introduction of micro-organisms into a surgical wound but attempts should also be directed to control the spreading of any infective foci which already exist in the living tissues. Regarding the surgeon and his assistants who have necessarily to come in contact with organs and tissues, the use of sterilized rubber gloves is imperative. Though there is no known method of keeping the hands absolutely sterile, the use of rubber gloves must not prevent the fullest and most detailed preparation of the hands before they are thrust into gloves.

The method for skin preparation I have used for a couple of decades and am still partial to is as follows:

Technic of Scrubbing the Hands of Surgeons and Assistants

Before entering the scrubroom, surgeons, assistants and nurses shall don the customary operating attire. Under no circumstances shall this operating outfit be worn over street clothes.

Anyone having an abrasion on the forearms, hands or fingers or who has

recently had contact with contagious diseases or putrefactive or septic material shall not participate in an operation before having cleansed himself thoroughly (antiseptic tub bath).

Shoes worn on the street must be changed to operating room shoes (tennis or special rubber shoes).

Cap and Mask. Before scrubbing is begun an operating cap and mask should be donned. Special care must be taken to cover all of one's hair and have the mask cover the nose as well as the mouth (Fig. [illegible]).

The finger nails shall be free from all foreign matter, such as liquid polish, and [illegible], etc., and should be trimmed short.

CLEANSING IS DONE AS FOLLOWS

Liquid green soap is supplied from an automatic container or if bar soap is used, it is kept in the hand lying on top of the brush when not in use. For many years, I have used a hard, alkaline surgical soap containing a moderate quantity of powdered pumice and found it very effective in removing superficial impurities. Wash the hands with warm, running water delivered by means of an automatic knee or foot pedal. Never use water in a wash basin because it simply represents a solution of dirt.

Wash the hands and arms four inches above the elbow with soap and hot water to loosen the dirt. Remove all subungual dirt with an orange wood stick or file.

Begin scrubbing with a medium soft, sterile brush. Start with the thumb of the left hand, follow to the index, middle, third and little fingers in succession. Scrub the palm of the hand, across the nails, up to and including the wrist. Rinse thoroughly and frequently during this process and use a fresh supply of soap. Repeat the same procedure on the right hand, wrist and forearm. Consider that each finger has four sides; brush each side; scrub between the fingers and go on to the next digit. Scrubbing in a haphazard manner is to be avoided. The forearms are scrubbed up and including at least two inches above the elbows.

Keep the arms flexed permitting the water or solution to drip from the elbows and not from the finger tips. Particular attention should be paid to the numerous corners and crevices about the nails and fingers; they are difficult to cleanse thoroughly. Allow a minimum of five minutes for the cleansing of one hand. Time the complete scrub period at a minimum of about fifteen minutes. This accomplished, rinse the hands in cold water to contract the pores. Some surgeons accomplish more in ten minutes of thorough, systematic scrubbing than others in half an hour of haphazard "dabbling." Also, too thorough scrubbing does more harm than good. Besides injuring the skin, remember that the Staphylococcus epidermidis albus cannot entirely be "scrubbed off," no matter how prolonged and vigorous one's efforts may be. Fortunately, this coccus is non-pathogenic; yet, under certain circumstances and favorable conditions many non-pathogenic micro-organisms may become pathogenic.

Keep the hands and arms flexed and away from the sides of the body; now scrub again in [illegible] per cent Lysol solution, sterile water and 70 per cent alcohol solution. The solution basins have a sterile glass label indicating solution. At least one minute should be allowed for the hands to soak

each solution. Finally the fingers are dipped into a cup containing some Metaphen Solution.

Don a sterile gown held by the "scrub" nurse (Figs. 12-13).

Dry the hands on a sterile towel.

Put on sterile gloves. (Fig. 14.) I have devised and used for many years a "glove cuff" over the gloved hands and forearms as shown in Fig. . This is good assurance against undesirable contact.

After all is said and done the most important factor in preparing the hands for a surgical operation is not the type of antiseptic used but how well the surgeon knows to take advantage of the proper use of soap and water.

Fig. 14. Wrong method of putting on operating gown.

Fig. 15. Proper method of putting on operating gown.

The surgeon and his personnel should never relax vigilance regarding the completeness of all aseptic precautions. His own habits of personal cleanliness go without saying.

Frequently washing of hands is resorted to in such manner that the bar of soap held by the surgeon is placed on the shelf, picked up again to be redeposited on the shelf innumerable times during the scrubbing procedure. It can readily be seen that contamination of the bar of soap and the hands is quite likely under such circumstances.

This is obviated by the various soap dispensing devices on the market of which the McKesson (Leisurley) Foot Pedal Liquid Soap Dispenser is an excellent

example (Fig. 15). The soap container is large, not requiring frequent refills and the pedestal as well as the pedal of sturdy construction. The dispensing nozzle may be swung into a position set for the convenience of a number of individuals who may use it for scrubbing. A simple piston arrangement in the soap pump delivers the soap equally. The amount of soap to be delivered at one stroke of the piston may be regulated to the individual requirements.

Fig. 16. Proper way of donning gloves by the surgeon. The nurse holds the glove and the surgeon plunges his hand into it as depicted.

Air Sterilization

Very recently aseptic technic has been extended to the sterilization of the operating-room air by the use of radiant energy having bactericidal properties (light in the ultra-violet spectrum, less than 2800 Angstroms wave length, with high bactericidal and low erythemal effect). Such irradiation has reduced almost to extinction those infections, usually staphylococcic, which arise from that general air infection which exists even in hospitals equipped with air filters. While all the air of the operating room is not sterilized, the lamps are powerful enough to kill any bacteria floating in from outside the operating field. Impermeable masks prevent bacteria being blown into the wound whence they may locate in spots protected from the lamp.

The advantages of such sterilization are: ability to reopen wounds without fear of lighting up buried infection; postoperative elevations of temperature are lower and of shorter duration and postoperative pain is reduced; the general systemic reaction has been less severe; healing has been more satisfactory and recovery more rapid.

Tubes (Fig. 18) emitting such light are placed over the operating table and the various instrument sections. Quiet silk masks, from which the air is removed by suction are worn to prevent all possibility of droplet infection and to protect the operating-room personnel from the light. This even if elevated as far as possible above the table is still very close to their heads, especially considering continuous exposure. Such masks have the additional advantage of necessitating less re-breathing than the ordinary ones.

Fig. . Foot-pedal liquid soap dispenser.

ANESTHETIZED PATIENT

After all aseptic precautions have been attended to, the steps to be taken after the anesthetized patient has reached the operating room are generally as follows:

Arranging the patient in the correct position on the operating table.

Exposure of the operative field and adequate protection of other parts of the body.

3. Final preparation of the skin if necessary.
4. Draping with sterile sheets.
5. Arrangement of accessory tables, stands and sponge racks.

These duties are allocated to definite members of the operating room personnel. The patient should be placed in that position which is most convenient to the surgeon for the particular operation, which does not unduly interfere with the functions of the anesthetist and which will not in any way contribute to pain (Fig. 17) or later disability of the patient. It must be remembered that the patient is unable to call attention to or complain of continuously uncomfortable or painful position which in most cases may involve nerves and ligaments to a degree that leads to temporary paralysis. The hands and arms of the patient should generally be placed in full extension along the sides of the trunk. No constriction on any part of the body should interfere with free circulation unless such is a part of the surgical technic. I have seen cases where

the neglect of such precautions, even in first class hospitals, have led to serious postoperative accidents to patients (Fig.).

In nonoperative surgery, such as orthopedic procedures, the skin of the affected area should be surgically prepared just as in the case of a cutting operation because it may become necessary to incise if the manipulative procedure fail.

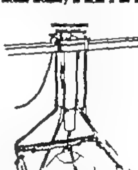


Fig. 18. Bactericidal radiation [illegible] (Designed by Westinghouse Lamp Co.) From Hart and Gardner: Trans. South. Surg. Assn., vol. 49, 1937.)

In open operations, no viscus or vital organ should be allowed to come into contact with the skin. Of course, there must be necessarily a good many exceptions to this general rule, but some surgeons go so far as to lift up all tissues with forceps and to thread needles and tie ligatures in the same way. The point is that traumatism and the possibility of infection should be abolished as far as possible. For the same reason before opening any hollow viscus every protection should be taken to isolate it. In abdominal work the intestines should be kept protected in the abdominal cavity except the particular portion demanding surgical attention. Such protection is best accomplished by the use

of hot saline compresses; the same remark applies when operations, such as the removal of the breast for carcinoma, calls for the opening up of extensive areas. When packing viscera away from infected or suspected areas, to protect them from contamination, dry packs should never be used as they stick to the surface of the bowel and, in the case of the bowel especially, when pulled away they undoubtedly injure the delicate serous membrane and invite formation of adhesions.

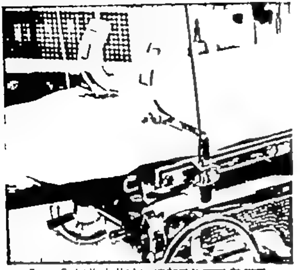


Fig. 17. Comfortable shoulder brace attachment to support the patient. ([illegible] Co.)

INCISION

In regard to incisions, the general rule is to use that incision which will permit good exposure of the underlying parts without inflicting injury to any important structures, so that there can be complete restoration of the anatomic relations and preservation of function of the parts. Other things being equal, for all operations, long incisions are much preferable to short ones. less force is necessitated in retracting wound edges with less consequent traumatism to the patient. Under aseptic conditions, the long incision will heal just as quickly as a short one. "Button-hole" incisions, as favored by some surgeons are to be deprecated; there is no justification in working in the dark as injuries may be inflicted to some organ without the surgeon being aware of it.

For any operation, the incision should be sufficiently large to give easy

access to the site of disease. It should preserve all nerves. It should avoid all unnecessary trauma to muscles; and it should preserve the vascular supply.

Although a separate chapter is devoted to surgical incisions yet the importance of abdominal incisions deserves a special word and here since there is much controversy regarding the relative value of vertical, oblique and transverse incisions. Kocher said that the only incisions in the abdomen which can be regarded as normal are the median and the transverse in the upper abdomen and the oblique passing from above downward and inward, in the lower part of the abdomen, for these incisions do not damage the nerves supplying the muscles of the abdominal wall. In certain cases, such as gall bladder surgery, a combination of these incisions may be used.

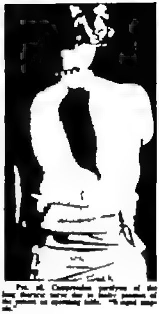


Fig. 18. Compression paralysis of the long thoracic nerve due to faulty position of the patient on operating table. "Winged scapula."

An extensive abdominal incision, apart from the median, paramedian or transverse, will more or less damage the nerve supply. The main objection to the median incision is the possibility of the occurrence of postoperative ventral hernia, and the statistics of the Mayo Clinic show that [illegible] per cent of the abdominal operations performed there were for ventral hernia following previous abdominal section. Kocher attributes this complication to imperfect asepsis and improper suturing, and recommends Lennander's incision to obtain good exposure and increased firmness along the line of suturing. This incision now goes under the name of paramedian and is made about one inch lateral to the midline. The anterior wall of the rectus sheath is divided in the line of the cutaneous incision and the inner leaf of the sheath dissected free, medially. The rectus is then drawn outward and the abdomen opened through the posterior layer of the sheath more or less in line with the anterior sheath incision. At the conclusion of the operation, the posterior layer consisting of the peritoneum and transversalis fascia, is sutured with catgut, every care being taken that the raw edges are everted. Ventral hernia rarely follows paramedian incision.

The transverse incision is advocated mainly because it is considered to be more anatomically and physiologically correct than others. The surgeon must decide, according to his experience and judgment and the nature of the operation, what incision or combination of incisions he will employ. In general

way it may be said that it is of no great surgical consequence which way the muscles are divided, especially the rectus abdominis, provided the re-suturing is correctly performed.

Adhesions are a common postoperative sequela, caused primarily by faulty surgical technic such as unnecessary bruising of delicate tissues, prolonged exposure, pulling and tearing of tissues, chemical irritation and forcible packing with large quantities of dry gauze. In the peritoneal cavity especially all surfaces should be covered with the [illegible] of peritoneum and at the end of the operation some surgeons use a bland solution such as sodium citrate or sterile olive oil in addition to [illegible] of any injured surfaces.

Foreign Bodies. With the perfection of technic arrived at in present day surgery it would seem almost impossible that there would be any risk of leaving behind in an opened cavity any surgical instrument. Nevertheless the fact remains that it happens from time to time even with most careful surgeons.

In emergency surgery as in industrial accidents and in severe traumatisms, such as compound fractures, where there is little time for preoperative treatment the wound should be freely opened up and cleansed thoroughly. Infected and devitalized tissues, including doubtful muscle tissue, should be removed with sharp knife and all debris removed. As elsewhere, gentleness of manipulation should be the keynote of treatment. All bleeding points should be secured and clots removed. Then, if the Carrel-Dakin method of wound irrigation is employed, the multiple tubes should be introduced in such a way that the whole wound field is thoroughly irrigated with the antiseptic fluid. Gauze compresses and packs may be employed but must not interfere with the action of the tubes. Dakin's Solution is a combination of chlorinated lime with bicarbonate of soda. It was used extensively in the World War and in civil surgery.

INFECTION

It is my impression, gained from a series of experiments on animals and from hospital work, that in most instances wound infections may be avoided by careful technic.

Most wound infections are caused by large quantities of catgut becoming imbedded in the abdominal wall. It is small wonder that the absorptive powers of the system become overburdened when one recalls the amount of catgut used in ligating vessels and closing wounds in abdominal operations.

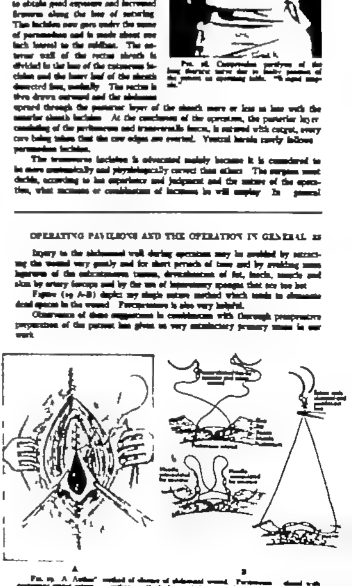
I often limit myself to a single catgut suture in closing the peritoneum. An occasional bleeding vessel is ligated, but forcipressure and torsion is usually depended upon for hemostasis. The remainder of the wound is closed with one dermal suture, or a suture of silkworm gut or silk. The type of suture material is not of so much importance as its sterility and nonabsorbability and the fact that it holds in its grip the fascia, panniculus adiposus and skin.

Following the study of 3000 abdominal wounds, in the Woman's Hospital of New York, Goff states that, "With all other factors remaining constant, the adoption of the silk sutures had, in the work of all surgeons who used them, invariably resulted in a very decided reduction in the incidence of faulty union. The total average incidence of faulty union in clean abdominal incisions from all causes, was 11 per cent in wounds closed by absorbable sutures, while with non-absorbable sutures it was only 3 per cent."

Injury to the abdominal wall during operations may be avoided by retracting the wound very gently and for short periods of time and by avoiding mass ligatures of the subcutaneous tissues, devitalization of fat, fascia, muscle and skin by artery forceps and by the use of laparotomy sponges that are too hot.

Figures (19 A-B) depict my single suture method which tends to eliminate dead spaces in the wound. Forcipressure is also very helpful.

Observance of these suggestions in combination with thorough preoperative preparation of the patient has given us very satisfactory primary union in our work.



A B

Fig. 19. A. Author's method of closure of abdominal wound. Peritoneum closed with continuous catgut suture. B. Author's method of wound closure. [illegible]

However, infections have been known to follow the most rigid aseptic and painstaking technic. Leaky or faulty sterilizers, insufficient scrubbing of the surgeons' hands, especially of the thumb, index and middle fingers of the right hand, torn gloves and the repeated use of the same alcohol for soaking the hands may all be sources of infection.

In injuries to the extremities it is much better to dress the limb with antiseptic dressing and delay operating for a day or so, to a time when there will be much less danger of shock and not infrequently a way may even be seen the limb may be saved.

It is frequently desirable to have an antiseptic dressing on for at least twenty-four hours before entering it.

In the surgery of special regions, such as in the [illegible]

brum and colon, which swarm with infectious organisms, extraordinary precautions must be taken. If the bowel is divided, swab the ends to be resected with iodine or still better use the diathermy knife.

In certain infections, some surgeons still irrigate the peritoneal cavity. One or two pints of saline is poured in slowly through a funnel and tube before the peritoneum is sutured. After some years' experience with peritoneal irrigations, I discontinued its use.

It may be remarked that catgut is often blamed for postoperative infections when in effect rough handling and poor surgery is the cause.

DRAINAGE

Finally, to drain or not to drain. The opinions of surgeons on this question are still at variance. The safe rule appears to be: that drainage is unnecessary when a surgical operation has been conducted aseptically and there has been no infection or manifestation of sepsis, but when there is any doubt in the surgeon's mind, the operative field should be drained. It should be remembered that drainage in itself is a necessary evil: the drain is always a foreign body which irritates and opens up an avenue for the entrance of infection.

Drainage is indicated:

1. When doubt exists as to the complete and efficient removal of infectious matter.
2. When complete hemostasis has not been obtained.
3. When some necrosis may be expected owing to severe lacerations or contusions.
4. When it is impossible to avoid an actual or potential cavity in the deeper layers of a wound in which serum, blood or pus may collect.

When they can be employed, gravity drains are the best. But drainage may also be effected against gravity and then depends upon reversal of the circulation in the local lymphatics. A drain or gauze pack invites an increased flow of lymph in an effort to extrude the foreign body. This flow of lymph flushes out the cavity. Suction and aspiration drainage, depending upon some external motor arrangement, or siphonage may be resorted to in some cases when the usual modes of drainage cannot be applied (Fig. 20).

Occasionally the removal of a drainage tube is followed by pyrexia, to the discomfiture of the surgeon. This need cause no alarm, for as a rule the fever is of a transient nature and without bad prognostic significance.

When drainage tubes should be removed is a question that must be decided by the indications in each individual case. Too prolonged retention of drainage tubes, as already pointed out, often proves dangerous and sometimes results in intestinal obstruction and fecal fistula from pressure necrosis. While this is so, I still find it difficult to be diverted from the dictum—When in doubt always drain. Numerous incidents in my experience have stressed the value of keeping this dictum inviolate, although I am fully aware that many experienced and competent surgeons hold the opposite view. For myself "experientia docet."

While much condemnation is directed against gauze drains, their judicious use often proves beneficial. Common sense as to quality and quantity of drainage material will yield good results. In our work we use rubber drains, cigarette

drains and gauze packs. The Mikulicz pack also has a distinct and valuable place in the armamentarium of the surgeon.

There are various methods by which drainage can be instituted, depending upon the nature, the quantity and the surroundings of the fluid which is to be drained. The types in most common use are the capillary, tubular, combined capillary and tubular, and absorbable drains. Of the capillary drains, several small lengths of catgut or silkworm gut placed together makes a suitable method of draining small amounts of serous exudates. A piece of gauze or wick may be used, but should be removed as soon as possible to prevent coagulation of the fluids in the drain. Another form of capillary drain is made by placing a piece of thin rubber tissue around a strip of gauze. This is known as the cigarette drain and has proved to be more efficient than the individual gauze drain.

There are several varieties of tubular drains. Ordinary rubber tubes about 1/2 inch in diameter are frequently used. The tube is perforated on its sides and at its distal end. A safety pin or suture may be used to keep the tube from slipping.

The rubber tubes are occasionally split longitudinally with resultant decreased rigidity.

Another type of tubular drain is the dressed drain, a rubber tube covered by several layers of iodoform gauze around which is placed a thin sheet of rubber tissue. It is very often used in surgery of the abdomen.

Wetherill's drain made out of rubber tubing is sometimes employed. Rigid tubes made from glass, celluloid or hard rubber are occasionally used. A rubber collar may be applied around the tube to which a safety pin or suture can be attached to prevent slipping of the tube.

The combined capillary and tubal drain is made by placing an ordinary rubber tube around a group of capillary drains.

Absorbable drains consist of the decalcified bone drain which was suggested by Neuber and the chicken-bone drain presented by Mertens. The chicken-bone drain is prepared as follows: denude the tibiae and femora of the chicken. Place in 10 per cent HCl until the bones are soft. Cut off the ends of the bone with scissors. Elevate the endosteum at one end and push it through to the other end together with its contents. Boil in a saturated solution of ammonium sulphate to sterilize. Wash with sterile water or an antiseptic solution. Preserve in alcohol or iodoform in alcohol solution. The durability of the tube in the tissues is about eight days. Durability may be enhanced by placing the bone in a sterile solution of chromic acid.

SURGICAL INSTRUMENTS

The importance of the quality and adaptability of surgical instruments should not be overlooked by the surgeon. Since the welfare of the patient may be endangered, it would seem fitting to require of the manufacturer an ethical responsibility equal to that of the surgeon who must rely so much upon the dependability of the instruments used.

If an instrument fails to qualify or seems inadequate to meet the requirements for which it was intended, the manufacturer should be held morally or

ethically responsible. It has been advocated that the name of the manufacturer in each case be made known so that other surgeons may be duly warned. A case has been reported where an operating table collapsed during an operation owing to defective construction.

It would seem a good idea for authoritative bodies to formulate some form of protection as a means of aiding the surgeon in the purchase of dependable instruments, that is, establishing a standard which manufacturers should be obliged to adhere to and which should serve as a guide to surgeons in choosing their equipment.

It might be well to mention here that a fellowship of the Mellon Institute of the University of Pittsburgh has for its very laudable objective the study of surgical supplies. Gerson has published an article outlining the scope of this work. Among other things, this fellowship is to determine the definite needs of surgeons and other specialists and to standardize products such as gauze, bandage materials, sutures, instruments, etc., from a scientific, rather than a commercial standpoint.

Manufacturers to whom the surgeon must turn for equipment to be used where life and future usefulness are in the balance should be governed by the high ethical standards of the medical profession rather than by the tenets of commercialism.

The assurance of perfect instruments does much to inspire confidence and assurance to the operator, while an accident occurring during an operation may be so upsetting to the surgeon as to endanger the life of the patient.

There would seem to be a modern tendency toward elevating the price and lowering the quality, fostered chiefly by sins of carelessness and indifference. There is no shortage of either materials or craftsmen in this country, so there would appear to be no reasonable excuse for putting anything but superior instruments on the market.

Figure shows a defective needle-holder; its appearance does not betray the defect. In use it either did not produce the desired tension on the loop or fell completely apart. This instrument repeated this performance several times before being discarded.

In Figure (A, B and C) three trephines are shown which broke during one operation. The skill with which they were applied was of ordinary dexterity. "A" had never been used before; observe the curved edge. "B" was considered an old and trustworthy instrument; it broke also. The third trephine "C" was brought into service but was discarded after a few turns on account of a broken guard. The fourth instrument served to complete the operation, which was performed under an intense mental strain lest another accident occur.

Figures and depict a varied collection of broken needles, forceps, scalpels, needles, etc. They speak for themselves except to say that such is an almost daily occurrence with many surgeons.

According to Jackson and Jackson, defects appearing in faulty surgical instruments may be due to (a) the use of poor or improper material, (b) defective design or (c) improper tempering of steel instruments.

Nonbreakable steel, vanadium steel and other alloys generally do not per-

Archives of Otolaryngology, Sept. 1930, Vol. 12, pp. 371-380.

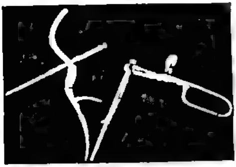


FIG. [illegible]. Tonsil snare broken during an operation.

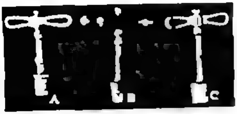


FIG. [illegible]. Three trephines, broken during . . . operations. The metal was too soft to resist the hardness of the bone.

FIG. [illegible]. Instruments broken during operations.

sess the suitable qualities necessary for delicate surgical instruments. All instruments which require an elastic action, saws, rasps, rongeurs, knives, shears, scissors, and cutting instruments generally should be made of the best tool steel. In manufacture hand-forging followed by hand filing, tempering, grinding and

FIG. 24. Broken needles.

sharpening by skilled workmen is necessary. At the most a few instruments may need to be glass hard at the cutting edge and far enough back for resharpening; for the rest tempering which will draw the hardness and prevent of breaking is necessary. Because rasps look like files (which have to be glass hard for

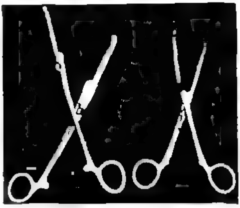


FIG. 25. Artery forceps that could not withstand the strain of torsion.

use on metal) such instruments are usually made glass-hard, accounting for broken rasps, snaps, etc. Temper can be tested with a file which will bite if the steel is tempered, and slide off if glass-hard. Since springs must have a good elastic action and be hard to a degree approximating the limit at which it will break

before it will retain its form permanently, they are unreliable—the more so because of the severe treatment which they receive. Any instrument which is to be bent back and forth must have all the hardening removed by annealing.

All surgical instruments should be cleaned immediately after use and stored in a dry place. The chlorine and acidity of city water will corrode them unless

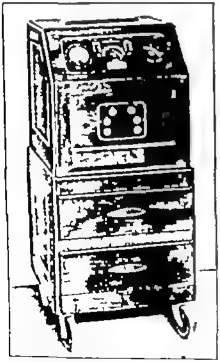


FIG. 26. Fischer short wave apparatus (43 meters.)

neutralized by sodium bicarbonate; sterilization by alcohol may rust them because of the denaturing substances. In sterilizing steel instruments it is well to remember that high temperatures often affect the temper of the steel and make it more brittle, hence it snaps, bends or breaks easily. Needles are rendered less

elastic and knives do not take such a keen edge. Instruments which have been subjected to heat or chemical sterilization should be retested before use.

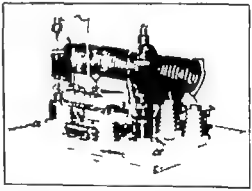


FIG. 27. Interior view of the apparatus depicted in Fig. 26 showing the construction of power oscillators (on upper platform) and insulated power transformer, controls, and rectifying tubes (on lower platform).

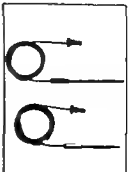


FIG. 28. Fischer's surgical bundles.

Specific surgical instruments will be alluded to in conjunction with the time in which they are used.

ELECTROSURGERY

In modern operating rooms many surgeons resort to electric currents for hemostasis, division of tissues and for destruction of neoplasms. The apparatus used for this purpose by the author is shown in Figures 26 and 27.

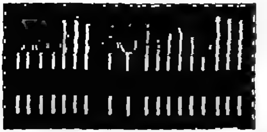


Fig. 26. Knives, scissors, electrodes and loops used in electrosurgery.

Space does not permit a thorough discussion of the subject; suffice it to say that the surgeon should possess at least a rudimentary knowledge of the physical properties of electric currents and their effects upon living tissues. A properly constructed diathermy apparatus may be used, but the short wave

Fig. 27. Author's foot switch.

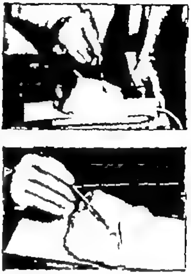
machines obviate insulating the patient thereby avoiding burns and permitting efficient work.

Accessories used in the short wave apparatus are a handle (Figs. 26-29) and a variety of loops, knife blades, needle points, scissors and coagulating ball electrodes to suit a given purpose.

For electrosurgical obliteration of the gallbladder (see author's operation) a special electrode is used.

I have found a good deal of inconvenience with the time-honored foot switch which tends to move about on the floor of the operating room. To remedy it, I have incorporated the switch in a substantial operating room stool which assures steadiness and comfort (Fig. 30).

The beginner will do well to become thoroughly acquainted with the technic of cutting and electrocoagulation. This is best accomplished by practicing on



Figs. 28 and 29. Practicing on raw beef. Electrocutting and coagulation.

pieces of raw beef. Dexterity soon is acquired (Figs. 28, 29). An acquaintance with the terminology now current will prove of value (see chapter on gallbladder surgery).

Wm. A. Gross found that the coagulated areas produced by sharp electrodes are pyramidal when using the long wave apparatus. When using the blunt electrode with the short wave apparatus the coagulated area is round and conforms more or less to the outline of the electrode. A cross section of the electrocoagulated tissue also shows that the depth of action of the current depends upon the amount of pressure used against the point of contact.

CHAPTER 3

STERILIZATION OF SURGICAL SUPPLIES

Paul Muni's picture—"The Story of Louis Pasteur"—brought to mind certain facts with which every surgeon will do well to refresh his memory from time to time. It is no exaggeration to state that in most surgeons, when things have been running smoothly for a long time, there is a tendency to relax from close observance of high standards—a state of mind that surely invites trouble.

In our modern hospitals with all the elaborate equipment now considered necessary it seems a far cry to those days when anyone would seriously question the need for precise methods of sterilizing. But it is just sixty years since

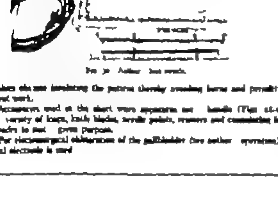


Fig. 31. Built-in sterilizer unit, American Hospital, Chicago. (Courtesy American Sterilizer Company.)

Robert Koch isolated the first known disease-producing organism—anthrax. During this period, the 1870's, Lister was proving that his antiseptic methods did avoid infections, and his only sterilizing agency was carbolic acid, and an infinitely painstaking personal attention to detail. Pasteur at that time was still trying to convince scientists that microbes do not spring into existence spontaneously.

The average surgeon is not called upon to supervise sterilization of his supplies, has in fact no voice (as he should) in the conduct of the surgery beyond the immediate field in which his work is done. He accepts the materials given him to work with on the supposition that someone else has subjected them to sterilization. In a well conducted hospital, usually nothing goes very

seriously wrong that could be charged to lax sterilization. Still, there are few surgeons who have not experienced difficulties with infections, gross or otherwise, that have been hard to explain.

I am convinced that a large percentage of these infections might be avoided and that imperfect sterilization or perhaps improper methods of handling sterile supplies accounts for too many of them. I am aware that surgeons have neither the time nor inclination to become sterilization experts, nor do I suggest that. They might advantageously inform themselves fundamentally about certain modern developments that are of paramount importance to the end that they are able to assist at least in an advisory capacity in the selection of suitable equipment, and in the establishment of systems of technic that are above criticism (Fig. 31).

The institution's sterilizing equipment need not be new to be thoroughly modern, certainly in so far as performance is concerned. Some of the most accurately performing apparatus I know of has been in use for many years. It is important to keep old sterilizers up to date, for at least two of the most outstanding developments applicable to sterilizers have been brought out in very recent years.

PREPARATION OF MATERIALS AND METHODS OF STERILIZATION

I shall not attempt to go deeply into this detail other than to suggest that there is a great need for the standardization of methods in accordance with plans which have been worked out scientifically. At the present every hospital establishes its own standards, more or less, too frequently from the standpoint of expediency and with insufficient thought about results. To cite a typical example: The surgical supervisor in a prominent hospital in her effort to protect hypodermic syringes from injury placed them individually in small test tubes, and closed the open ends with tight fitting corks. Of course there was no sterilizing effect at all because steam could not enter the tube. In another hospital a new method of sterilizing rubber gloves was instituted—a system of formaldehyde sterilization about the equivalent of the metal boxes used in barber shops marked "Sterilizer." This system was used until a series of postoperative infections resulted in an overhauling of sterilizing procedures, and the return to the steam method.

The interested reader will find much worthwhile information in condensed form in Weeden B. Underwood's "A Textbook of Sterilization." This little volume of about one hundred pages is brim full with essentials pertinent to the subject of sterilization. It condenses the principles of the substances upon which the important subject of sterilization is built in a most admirable and comprehensive manner. Particularly the surgeon who must "read and run" will find it of inestimable value.

INSTRUMENTS AND UTENSILS

Boiling. No one can seriously criticize the old system of thorough boiling for instruments and utensils, preferably in water containing 1% sodium carbonate. The period of boiling, however, is important and is too often cut short. Normally the period should be from 5 to 10 minutes with instruments or

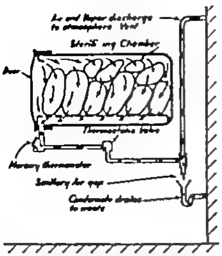


FIG. 32. [illegible]

[illegible]

utensils entirely covered with water. Under no circumstances should the period of boiling be reduced below 5 minutes except with the expressed approval of the surgeon, perhaps in pressing emergency, then the period may be reduced to 10 minutes.

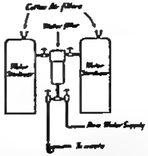


FIG. 33. [illegible]

[illegible]

Steam Pressure. In many hospitals both utensils and instruments are now being sterilized by steam pressure and special sterilizers are constructed for the purpose. The method is desirable because it undoubtedly adds to the safety factor and requires no greater period of time—10 to 15 minutes being ample.

One marked advantage in this system is that it eliminates the formation of lime or scale on the instruments or utensils, which is highly objectionable in localities where the raw water contains impurities which deposit in this way.

Oil Sterilization. The use of oil sterilizers for delicate cutting instruments, I believe, should be discouraged. It is questionable whether the temperature actually developed in such apparatus is sufficiently high to assure sterilization, at least, of resistant organisms, in the brief interval of exposure demanded. The recommended period is 10 to 15 minutes at about 300° F. or slightly higher. The performance is strictly dry heat sterilization since no moisture is present and according to all authorities on this subject, the temperature should be very much higher and the period longer. One investigator, Dr. E. E. Ecker of the University Hospitals of Cleveland, thinks that the temperature should be at least 338°-356° F. and the period not less than 15 minutes. At this higher

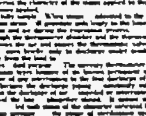


FIG. 34. [illegible]

[illegible]

range of temperature the oil is inclined to disintegrate and certainly the fumes given off are most objectionable. I am inclined to believe also, that the removal of all from instruments following sterilization by this method may offer further opportunity for recontamination.

SOLUTIONS

This subject is of tremendous importance and it is much misunderstood. Like sterile water, solutions in the process of sterilizing and cooling breathe in a manner which subjects them to contamination. When the sterilized flask is removed from the sterilizer it begins immediately to cool and to draw in air. If the flask is not well protected the intaken air will certainly contaminate. The necessity is a method of stoppering which will effectually filter all dust from the air taken in.

Stoppering. There are so many methods in use that it is difficult to separate

rate the good ones from the bad ones, but many that are in use are distinctly open to criticism. It is probable that the most effective system involves the use of fluted paper caps which are now available, made from fairly stiff, smooth coated paper shaped to fit the commonly used sizes of flasks. This paper cap is bound on with cotton tape very compactly against the neck of the flask, preferably covered with two or three thicknesses of muslin also bound on into a neat cover. The use of gauze, cotton or muslin for the inner cover of the flask, next to the solution, is objectionable because of the probability that shreds of lint will find their way into the solution.

Exhaustion of Sterilizer. Certain methods of sterilizing, however, will render useless the most elaborately planned system of stoppering. If the sterilizer pressure is exhausted rapidly following sterilization, there will be very rapid ebullition of the liquid which will saturate the stopper and cause a considerable part of the solution to boil over into the sterilizer. Once saturated, no stopper can properly protect the solution. To avoid this sort of thing, solutions should always be sterilized by themselves, and following sterilization, heat should be turned off and the entire sterilizer permitted to cool as slowly as possible. In this way provided the flasks have not been filled more than about two-thirds full, there will be a minimum loss of solution from the flasks due to evaporation and no rapid ebullition which will saturate the stoppers.

PROTECTION OF STERILIZED WATER

This detail I consider to be of sufficient importance to justify considerable thought. Water is very easily rendered sterile but it is subject to radical contaminating influences as I shall attempt to show.

Multiple Valve, Stone Filter Systems. The older system of filtering water as it is delivered from the supply line to the two sterilizing reservoirs, makes use of a single stone filter having valved connections to the raw water supply, to the drainage system, and to each of the two reservoirs. It is a physical impossibility to guard against leakage of valves and with this multiplicity of valves there is far too much opportunity for undetected pollution of the sterile supply. In addition these filters cannot be sterilized at all—they collect filth from the water passing through them for weeks or perhaps months, before they are cleaned at all—become excellent breeding grounds for bacteria which adds further to the possibility for pollution.

Similarly the method of filtering the air taken into water sterilizers as water is withdrawn, by drawing it through cotton filled cups, has been proved to be totally ineffective. Many water sterilizers make no provision, however, for the filtration of air.

Water in the process of sterilizing and cooling actually breathes, and this fact accentuates the opportunity for pollution from raw water or air. When heated as in sterilizing, steam forms and pressure is created and some steam will escape from various openings. Then when the water is cooled the condensation of steam causes a high degree of vacuum which will draw in impurities, either water or air, through any unprotected opening that exists. This detail is of far more importance than appears on the surface. These dangerous sources of contamination are most difficult to detect because the intake of polluted cannot be observed by the operator. If the water filtering system em-

leaky connection to the drain, the intake will come directly from the sewage system. In one test case of which I am aware colonies of colon bacilli were found on the surface of a stone filter 6 from the sterile water reservoir with no protection between, except one leaky valve.

This sort of thing has no place in modern surgery—should not be tolerated. Frequent tests of sterile water after it has cooled to room temperature and after two-thirds or more of the capacity of the tank has been exhausted, and after the water has been standing several hours will be indicative of its purity. Tests made immediately after sterilization are useless because the infection drawn in commonly must be given an opportunity to mix with the water in the reservoir, part of which is of course sterile.

Single Valve System. One manufacturer has appreciated the common faults of our older system of filtering air and water and has developed protective features of infinite value. Each reservoir has an individual water and air filter combined with but one valve controlling it. That one valve serves a dual purpose. When opened it delivers filtered water to the reservoir and the flow of water is visible to the operator through a glass cover. When this valve is closed against the flow of water a secondary outlet is opened up through which any leakage of raw water through the valve is conducted directly to an open funnel waste, rather than to the water reservoir. The open funnel disposes of any possibility of contamination from the waste system, a most important detail.

There is no opening to the sterile water reservoir through which air is drawn except through the filtering system which is so constructed that it effectually removes the dust from intaken air. The entire filter is automatically sterilized by steam pressure each time the water is sterilized, leaving it free from contaminating organisms which otherwise might find their way into the sterilizer.

TEMPERATURE CONTROL OF PRESSURE STEAM STERILIZERS

Steam sterilization of surgical supplies is the most critical of all surgical sterilization procedures—most subject to failure. The older method as followed in most hospitals today provides the operator no gauge of the true sterilizing function of the machine other than the pressure, whereas the one factor in which we are interested (temperature) is not measured at all. Pressure of course is necessary in order to secure the higher temperatures required, but it by no means follows that adequate temperatures are secured merely by the application of pressure. On the contrary sterilizer load temperatures can and do vary under the pressure controlled system all the way from slightly higher than room temperatures up to the full possible temperature of the steam. To this fact—the blind use of pressure gauges with no measured regard for temperatures—must be charged many sterilization failures.

We need no longer be handicapped by this obviously faulty system. Modern sterilizers can be made to include provision for measuring the temperature of the applied steam—at the coolest part of the sterilizing chamber. The apparatus to which I refer provides a mercury thermometer as reliable as our clinical thermometers, in the lower outlet from the chamber in which position it has the marked advantage of indicating the temperature at the coolest location—a class protective against false indications. This is an important feature because when

sterilizers are air charged—the common cause of failure—variations within the chamber may be very great. The discharge outlet is the coolest point because any air within the chamber will gravitate unfailingly to that point and, of course, reduce the temperature.

This feature is quite easily applicable to old sterilizers and every surgeon is perfectly justified in insisting that this safeguarding feature be provided. It ranks perhaps as the most outstanding improvement in sterilizer design since Pasteur's time.

CHAPTER 6

ANESTHESIA

GENERAL ANESTHESIA

Although at the present time at least in all hospitals of any size, general anesthesia is induced by specially trained assistants or professional anesthetists—as it should be—it must, nevertheless, be remembered that the surgeon who undertakes to perform an operation is responsible for every phase of it, including the administration and maintenance of anesthesia; also that the emergencies of general surgical practice may demand the carrying out of such procedures by the surgeon himself. Hence, it is necessary and expedient that the surgeon should be thoroughly acquainted with most of the methods of anesthesia in actual practice and be familiar with the practical application of them.

The first and most important question in connection with anesthesia is the safety of the patient, and although there is no known method of inducing general anesthesia that is entirely free from danger yet the danger differs in degree according to the anesthetic agent used, the amount used and the mode in which it is administered as well as the condition and adaptability of the particular patient. In some diseased conditions certain anesthetic agents are entirely prohibited; in others they must be given with watchfulness; in all cases circumspection and care must be employed, not only because of the physiologic action of the drug used, but because the carrying out of a surgical operation may profoundly change the tolerance of a patient to the action of the drug as well as to anesthesia itself. The actual effect of many drugs used for anesthesia on diseased and healthy tissues is not too well known and although experience may reasonably be relied upon in anticipating results, yet no absolutely definite prediction may be given in any particular case.

PREPARATION OF PATIENT

The respiratory system should be carefully checked in the preparation of the patient for anesthetization. Also kidney function should be normal because some anesthetics particularly affect the kidneys. Purgatives should be avoided; mild laxatives may be given. Enemas dehydrate the patient. Glucose is valuable and helps to combat postoperative acid intoxication.

No solid food should be given for six hours prior to the administration of a general anesthetic. The mouth and throat should be washed out with an antiseptic solution and all foreign substances, such as dental plates, removed. The bladder should be emptied either voluntarily or by catheter. In the case of an emergency operation, the stomach contents may be washed out, if necessary.

INDUCTION

General anesthesia may be induced by the inhalation of gaseous vapor or the introduction of the anesthetizing agent into the rectum or the vascular [illegible]

The chemical agents commonly used are ether, nitrous oxide, ethyl chloride, [illegible]

ethyl bromide, chloroform (rarely used in America) and the barbiturates. A few other substances have been tried but these are less for various reasons and because general.

The variety of agents and the diversity of methods have made it possible to induce general anesthesia without especially severe danger in almost any condition. For instance, compensated cardiac cases do not contraindicate general anesthesia, particularly if nitrous oxide and oxygen or ethylene be used.

There are four phases or stages in inducing general anesthesia.

The first stage ends at the loss of voluntary self-control: the higher cortical centers lose their activity, pain sense is lost; the conjunctival reflex is partly abolished.

The second stage of anesthesia ends with loss of consciousness.

3. The third stage, or deep anesthesia, ends with muscular relaxation. This is the stage required for major surgical operations.
4. There is a fourth stage to be feared—that of respiratory paralysis, generally due to an overdose of the anesthetic agent.

Fig. 37. A, [illegible] mouth gag [illegible] by [illegible] and [illegible]. Large [illegible] [illegible] pressure [illegible] [illegible] [illegible] mouth. B, [illegible]

The pupillary reaction is the most reliable guide to the depth of anesthesia.

Obstruction of the airways may result from:

The falling back of the tongue, obstructing the pharynx.

The presence of a large amount of saliva, mucus or vomitus in the air passages and back of the throat.

3. Closure of the lips when the nostrils are blocked.

Spasm of the larynx,

and that may be remedied by:

Forcible opening of the mouth (Fig. 37 [a & b], Fig. 38)

Pulling the tongue forward

3. The use of a wire breathing tube (Fig. 39, [a & b]) and

Removal of secretions with gauze swabs on forceps (Fig. 40)

Cardiac failure may occur as a result of overdosage of the anesthetic used or it may sometimes supervene in the first or excitement phase of light anesthesia, particularly if chloroform is the anesthetic used. Such an emergency is usually announced with (a) a fall in blood pressure, (b) irregular and rapid pulse and (c) pallor. The symptoms are those of impeded or arrested circulation: the jaw drops, the face becomes ashen, the lips are livid, the pupils dilate, there is gasping and finally cessation of respiration. The treatment is:

Prompt artificial respiration (Figs. 41, 42, 43, 44, [illegible]).

Massage of the heart (Fig. 49) and

3. Intracardiac injection of adrenalin (see chapter on "Surgery of the Chest").

Generally speaking, the patient is under better control in the case of

Fig. 38. Forcible opening of mouth [illegible]

respiratory or cardiac failure with inhalation anesthesia than with rectal anesthesia. Inhalation anesthesia with nitrous oxide or ether is easier to control than chloroform. (In India and other tropical countries chloroform is still used because of the excessive volatility of ether.)

All types of breathing may be observed during anesthesia from the deep respirations of the strong patient to the feeble breathing of the fragile child.

A B

Fig. 39. [illegible] Breathing tube and [illegible] B, other [illegible] tube.

Rapid breathing is usually due to nervousness or to the need for more oxygen.

Deep breathing usually indicates surgical anesthesia, but if muscular twitching is also present, it may denote the presence of asphyxia.

Shallow breathing is usually noted when consciousness is lost under light

anesthesia. In deep anesthesia, it may indicate the approach of respiratory paralysis.

Irregular breathing is generally considered to denote impending central respiratory paralysis.

An anesthesia record should be kept and recording done during the operation. Untoward manifestations during anesthesia should be reported to the surgeon at once. The anesthetist should maintain a quiet, cheerful and confident attitude at all times and should be concerned with nothing but the administration of the anesthetic and the effect thereof on the patient.

Anesthesia may be induced in almost any posture of the patient required by the surgeon, but care should be taken to avoid pressure on nerves as this may result in pressure-paralysis. This refers particularly to abduction of the arm and unusual postures of the legs. Such nerve pressure paralyses are sometimes very painful and persistent.

Fig. 40. [illegible] during anesthesia. [illegible] which consists of [illegible] the base of the tongue [illegible] with [illegible] held in the [illegible] simple and effectual [illegible]

ETHER

Ether still is [illegible] administered, and in the absence of contra-indications, the anesthetic par excellence, although in hot climates climatological conditions often force the surgeon to use chloroform.

Ether is less powerful in its anesthetic effects than chloroform but more so than nitrous oxide. It is therefore used mostly for a great number of operative procedures. Ether stimulates the heart, the respiratory and circulatory systems. It causes excitation in the first stage, coughing and a great increase in the secretion of saliva and mucus. It does not, so far as is known, give rise to primary heart failure. Aside from the initial excitation and irritation caused in some patients, and nervous depression, the only serious drawback to ether as a general anesthetic is the fact that its vapor is explosive.

Ether may be administered either by the open or closed method. The first allows the patient plenty of air; the second is a rebreathing method. The first or open method allows an even administration and helps to prevent the occurrence of the so-called ether pneumonia. Prolonged ether administration should be avoided in poor risks (cancer, rise in arterial pressure), in septic cases and in operations upon damaged kidneys.

In operations about the head, the nature of which prevents the use of a cone over the nose and mouth, the intrapharyngeal or intratracheal method of administration, or rather maintaining, ether anesthesia is employed. The initial induction is by the usual inhalation method. A rubber tube is then passed into

Fig. 41. "Sylvester" method of artificial respiration, first movement.

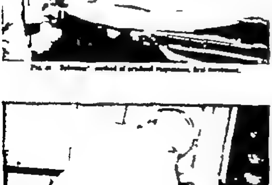


Fig. 42. "Sylvester" method of artificial respiration, second movement.

same as those of endotracheal insufflation, viz., existing obstruction of the upper air passages is overcome by a tidal bulk which is delivered behind and below the base of the tongue; mucus, saliva and blood is thrust outward by an air stream, thus minimizing "ether pneumonia"; and the anesthesia is even and full.

Technic. Use the same air pressure and vapor apparatus as for endotracheal insufflation. A metallic Y-forked tube shaped to fit the nose and forehead, is used as delivery device. Each fork is equipped with an No. 18 F. soft rubber catheter about 13 cm. long with double or multiple eyelets. (Fig. 55.)

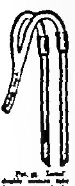


Fig. 55. Lateral double nasal tube for use through the nose.

Step 1. Induce anesthesia in the usual way; if ether is employed insufflation is not started for 5 or [illegible] minutes.

Step 2. Lubricate the catheters. Tilt the nose upward and introduce a catheter into each nostril along the inferior meatus of the nasal chamber directing the catheter toward the pharynx. If one naris is obstructed introduce both catheters in the other. If both are obstructed, introduce the catheters into the mouth. Insertion is continued until the eyelet of the catheter lies at the level of the epiglottis (about [illegible] cm.).

Step 3. A bent tube introduced into the lower pharynx via the mouth may also be used (see Fig. 59). However the nasal route is preferable because the tubes are properly placed and held in position better.

The amount of anesthetic agent administered should be sufficient to meet the needs of each inspiration without extraneous dilution. Insufflation of about 18 liters per minute usually suffices though it may be lessened or raised according to the needs of the patient.

INTRATRACHEAL INSUFFLATION

Intratracheal insufflation consists of the introduction of ether vapor into the trachea at a point close to its bifurcation. One long tube is used to deliver the ether past the vocal cords and upper air passages where respiratory obstruction is most likely to take place.

Inspiration is made easy for the patient by the introduction of the vapor under pressure directly into the trachea. A tube, of much smaller diameter than the glottis, provides for expiration and for the escape of any excess vapor. Instead of concentrated ether vapor diluted with atmospheric air, a volume of vapor sufficient for all the respiratory needs of the patient is given. This volume under sufficient pressure is such that even during the inspiration, with the glottis but partially obstructed by the tube, no atmospheric air will enter; there will be no inward flow at any time into the trachea along the sides of the tube. On the contrary, there should be a constant flow to the outside. This flow will naturally be less at the time of inspiration but it will never altogether cease except when the delivery is cut off. Since the lungs do contract at regular intervals during normal respiration, this action should be stimulated by frequently releasing the positive pressure.

Flagg, Paul, Anesthesia, J. B. Lippincott Co., 1932.

The necessary apparatus consists of Connell's anesthetometer, an intratracheal catheter, a laryngoscope and mouth prop. (Figs. 56, 57, 58, 59.)

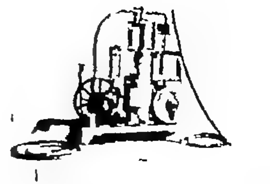


Fig. 56. The Connell insufflation ... apparatus. (Flagg, Anesthesia, J. B. Lippincott Company.)

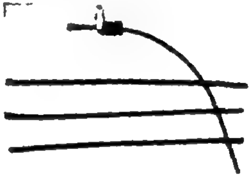


Fig. 57. Intratracheal catheter and special mouth prop. (Flagg, Anesthesia, J. B. Lippincott Company.)

Technic.

Step 1. Place 4 silk-woven urethral catheters marked off 10½ inches from the tip, in a container of ice-water.

Step 2. Make sure that the anesthetometer is delivering 30 mm. of vapor ten-

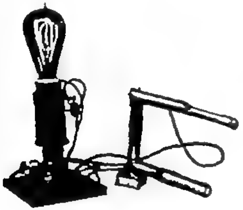


Fig. 58. Jackson laryngoscope and dilator. (Flagg, Anesthesia, J. B. Lippincott Company.)

Fig. 59. Scheme illustrating the ... [illegible] ... (Flagg, Anesthesia, J. B. Lippincott Company.)

sion, that the emergency gauge is working and regulate the pressure so that it remains between 18 and 20 mm. of mercury. Have the foot bellows at hand and see that the light in the laryngoscope is working.

Step 3. Induce anesthesia either by the semi-open or closed drop method. Do not attempt intubation before anesthetizing the larynx.

Step 4. After the patient is anesthetized and reclining flat on his back, grasp the head, extending it so that the chin forms almost a straight line with the sternum and neck. Grasp the laryngoscope in the left hand and slip it over the upper part of the tongue exposing the epiglottis. Slip the tip of the instrument over the epiglottis and raise the tongue and attached muscles (Fig. 60).

Fig. 60. Intratracheal insufflation anesthesia.

Step 5. While holding the laryngoscope in the left hand, grasp a prepared catheter in the right hand and slip it through the laryngoscope into the glottis up to the 10½ inch mark. Coughing of air will follow and the patient may cough; however, normal breathing is quickly resumed. A hissing sound is emitted when the catheter is placed in position assures the surgeon that it has been properly placed. If it is not heard, it is likely that the tube has slipped into the esophagus.

Step 6. Place the mouth prop in position, insert the delivery tube and connect the machine. From this point the procedure is much the same as that followed during intrapharyngeal anesthesia except that the flow is interrupted two, three or four times a minute by pinching the tube. Maintenance is ideal, if the agent is properly administered.

Step 7. Quick recovery takes place when the valve is turned to pure air, thus expelling all ether from the lungs. Detach the tube, permitting the patient to breathe through the catheter for a few minutes then withdrawing it slowly. Postoperative illness is very rare; the vocal cords are seldom injured.

[illegible] by the catheter. There is no need to worry over pulmonary complications.

TECHNIQUE FOR INTRATRACHEAL ANESTHESIA

The apparatus for the administration of intratracheal anesthesia has been improved greatly during recent years. Flagg states that when Magill of London introduced his [illegible] catheter holder it occurred to him that one [illegible] which would enable the patient to breathe easily [illegible] would be a welcome innovation.

Three different sizes of inhalation tubes are now furnished with Flagg's intratracheal inhalation apparatus (Fig. [illegible]) which are designed to fit men, women and infants. By using this instrument the surgeon is able to apply the principles of bronchoscopy and is assured by the [illegible] and control of the [illegible].

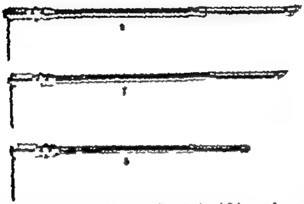


Fig. [illegible]. Flagg intratracheal inhalation tube. (Flagg: Anesthesia. J. B. Lippincott Company.)

The Flagg apparatus is composed of [illegible] rigid and [illegible] flexible portion. The rigid part is long enough so that the tube is [illegible] [illegible] the patient's head is bent [illegible] may be extended by extending the head. The instrument is chromium-plated with [illegible] spring. The flexible portion is protected by [illegible] tubing which is replaced [illegible] necessary. The tube may be utilized in administering ether from the container or nitrous oxide with oxygen and [illegible] from [illegible] gas machine.

At the same time that Flagg was improving the intratracheal inhalation tube, he was also working on [illegible] laryngoscope which was composed of [illegible] blade, [illegible] handle and dry batteries (Fig. [illegible]). The blades are durable and the dry batteries may be easily replenished [illegible] the flashlight [illegible] replaced the [illegible] and inhalation technic, except in chest surgery. The apparatus is easily transported, tends to improve the [illegible] of the patient and gives better care of the [illegible] in the absence of morphine and [illegible]. [illegible]

should be instituted preceding, during and following intubation and extubation. A No. 14 French catheter is of aid here.

Intubation Technic.

Step 1. Administer gas or ether until the patient is completely relaxed. Have the intratracheal tube, connecting tube and laryngoscope all sterilized, at hand.

Step 2. Remove the inhaler and pharyngeal tube. Practice suction of the pharynx. Extend the patient's head. Grasp the laryngoscope in the left hand.

Step 3. Separate the lips and teeth of the patient with the fingers and insert the laryngoscope over the tongue. Expose the epiglottis. Insert the tip of the laryngoscope beyond the epiglottis, lift up the tongue and expose the larynx.

Step 4. Carefully introduce the intratracheal tube between the vocal cords. Inhalation will separate the cords in case of spasm. Remove the stylet from the intratracheal tube, remove the laryngoscope and bend the patient's head. The patient will now breathe easily through the tube. Connect tube to the anesthesia container.

Fig. [illegible]. Flagg laryngoscope. (Flagg's Anesthesia. J. B. Lippincott Company.)

Step 5. If the operation does not include the mouth, pack strip of gauze saturated with glycerin into the pharynx. The use of [illegible] mouth gag and lubricant on the tip of the tube often facilitates the procedure.

Comment. The larynx is less likely to be injured when exposed under anesthesia than while the patient is conscious. The muscular relaxation which follows permits the use of the instrument to be used on all patients. The use of an anesthetic permits the surgeon to be more deliberate in the steps of intubation and thus serves as a safety measure. An intratracheal tube which fits easily into the larynx is more satisfactory than one which fits too snugly.

Blood, mucus or fluid passing down the sides of the tube are soon detected by the respiratory sounds. Full information will prevent respiratory spasm. The following practical hints have been garnered from Flagg's excellent work on anesthesia.

Increase the depth of the anesthesia if continued spasm of the vocal cords ensues. Respiratory spasm may be due to the loss of the freshly [illegible] or to other causes but is not alarming if the color and pulse of the patient are satisfactory. Breathing or blowing oxygen through the intratracheal tube may relieve spasm.

Removable dentures should not be left in place during this procedure. The laryngoscope is likely to break [illegible] teeth as well as caps. [illegible]

prevent postoperative soreness of the pharynx, apply oiled gauze over the tongue and take plenty of time to pack the dry gauze.

If the patient coughs persistently withdraw the tube one or two inches. In some instances the airway may be obstructed even though the tube is apparently properly placed. In such cases it may be withdrawn too far with the patient's head extended or the rubber covering may have split permitting air to escape from the side of the tube. If the patient seems to be breathing through the mouth while the tube is in place, it is an indication that the tube is too small and that [illegible] larger size should be substituted.

If the suction shows [illegible] quantity of blood or mucus upon suction, the tube is probably too small and the pack in the pharynx displaced. This may also be caused by [illegible] defect in the rubber cover or to the catheter having been left in the tube too long.

If intubation is difficult, administer anesthesia.

The tube is in the esophagus if the patient breathes quietly with little air coming through the tube. A dry tube introduced during spasm of the vocal cords is likely to result in injury to the mucous membrane. Extubation should be aided by lifting the rigid portion of the instrument upward with the finger tips, out of the mouth.

Intratracheal insufflation eliminates the necessity for apparatus designed to warm and heat the anesthetic vapor. It keeps the field of operation free from exhaled vapor as well as anesthetic.

Normal respiration is maintained and the [illegible] supply is [illegible]. Blood and foreign matter are excluded. Light anesthesia may be employed and artificial respiration controlled by simple methods. It makes possible the [illegible] through the tube and [illegible] by ether, [illegible], oxygen, [illegible] etc. The trachea is protected from external pressure. A light ether anesthesia makes possible [illegible] field of operation similar to that produced by chloroform and protects against blood aspiration. It also affords no surgeon field for plastic operations on the face.

The chief advantages of this method are: It prevents lung collapse during intrathoracic operations; it is specifically indicated for intra-oral operations (tumors of the tongue, lower jaw and cleft palate operations); for operations on the head, neck, trachea and larynx; in emergency operations for intestinal obstructions where vomiting may collect in the upper air passages, etc. The return flow of air insures blood, pus, secretions and infections material to be expelled thus diminishing the danger from pulmonary infections.

On the other hand, the disadvantages are: [illegible] special, detailed knowledge of the technic is absolutely essential; expensive and complex equipment is necessary. Deep anesthesia must be induced before introduction of the tube by the novice; anesthesia by direct vision is necessary; and the intratracheal tube is present in the mouth.

CHLOROFORM

Any degree of anesthesia from analgesia to deep narcosis may be produced by the inhalation of chloroform. It has the advantage that it is easily administered, requires no elaborate apparatus, does not carry with it the danger of explosion and is perhaps the pleasantest method for the patient. On the other hand, drop narcosis by chloroform may have severe effects on the system, namely, chloroform poisoning, expressed particularly by edema and necrosis of the liver, [illegible] dilatation and degeneration of the muscle of the heart. Unlike ether, chloroform does not irritate the respiratory passages. Its use should not be forced in the case of struggling children. It is contra-indicated in the case of patients in shock or when shock is likely to be produced by the operation, also in alcoholics or in patients with septic infections or in [illegible]. Chloroform is not as suitable for very lengthy operations as are other anesthetic agents.

ANESTHETIC MIXTURES

The so-called A. C. E. mixtures which consist of one part alcohol, two parts chloroform and three parts ether, or some modification of this formula, has been very popular in Europe, the object being to counteract any tendency to circulatory depression from [illegible] concentrated chloroform vapor. The chief objection to this mixture is that the ingredients do not vaporize at the same rate, the more volatile agent evaporating first. The results of this method are similar to those of chloroform.

Although perhaps less dangerous than chloroform alone the accidents attributed to the use of these mixtures are numerous and they are less safe than ether alone. Gwathmey is partial to [illegible] anesthetic mixture inhaled through an [illegible] apparatus.

ETHYL CHLORIDE

The inhalation of ethyl chloride causes [illegible] very rapid loss of consciousness without excitation. Hence, it may be used on account of its rapid effect before the induction of general anesthesia by ether and this perhaps is its greatest indication. It is only suitable for short operations because the margin of safety between the stage of surgical anesthesia and [illegible] dose is rather small. It depresses the circulation, the patient's color does not change as [illegible] rule hence there is no warning sign of approaching danger.

Many surgeons believe that the use of ethyl chloride is as dangerous as that of chloroform and its mortality rate is high. Death from this anesthetic agent is due to respiratory failure which precedes cardiac failure. In any case, its use is likely to be followed by headache, nausea and vomiting to an excessive degree, in some cases.

Ethyl bromide has the same physical effects as ethyl chloride and is used as an anesthetic agent to [illegible] limited degree. Many believe it to be more objectionable than the chloride. Both the chloride and bromide are inflammable.

NITROUS OXIDE

Nitrous oxide gas, with or without oxygen, is the anesthetic of choice for short surgical operations [illegible] adequate general anesthesia. It has all the advantages [illegible] disadvantages than ethyl chloride. There is rapid [illegible] of [illegible] with fewer after effects. It is not suitable [illegible] be used for cardiac patients or for [illegible]

ing from acute infections. It does not give as much muscular relaxation as ether and where this is necessary its use may have to be supplemented by ether vapor. Patients whose respiration is not too good or where cardiac action is affected should get plenty of oxygen with the nitrous oxide. The objection to nitrous oxide and oxygen anesthesia is that it requires a cumbersome apparatus and generally must be administered by one specially trained in its technic, yet it is worth the expense and trouble. Its use is coming gradually but surely to the fore in major surgical procedures.

The special features of gas anesthesia are the steady deepening of respirations and the dusky cyanosed look of the face; the pupils dilate, the eyeballs roll, and the conjunctival reflex is lost.

Divinyl-ether (vinethene [illegible]) is useful in reinforcing nitrous oxide-oxygen anesthesia. It is highly volatile. One of its chief advantages is the absence of nausea. It adds to the smoothness of anesthesia for example in thyroidectomies where nitrous oxide-oxygen is used. It is of much value in thoracic surgery. It may be administered by the open method, preferably admixed with nitrous oxide-oxygen. Goldman's vaporizer is excellent in its use. (Avoid prolonged administration (effect on liver).)

In the hands of an expert anesthetist, I prefer nitrous oxide-oxygen for goiter operations and other procedures about the head and neck. In surgery of the thorax and abdomen, ethylene anesthesia, properly administered, has served well.

PRE-ANESTHETIC MEDICATION

Many patients have an exaggerated dread of anesthesia and the anticipation of passing through the ordeal fills them with fear, restlessness and anxiety which very often interferes with the easy induction of anesthesia. Within recent years many methods have been devised to overcome this condition by the use of medicaments termed pre-anesthetics. These generally are alkaloidal sedatives which allay the apprehension of nervous patients, make induction of anesthesia easier and make it possible to maintain anesthesia with a smaller amount of the anesthetizing agent than is ordinarily employed. The patient is in a semi-conscious condition when the anesthetic is administered and since the drowsy effect of the pre-anesthetic lasts much longer than that of the anesthetic, the patient remains asleep much longer than usual. The disadvantages of pre-anesthetics are generally that their use abolishes certain eye reflexes which inform the surgeon or anesthetist of the progress of anesthesia. The safety of the patient, which has already been mentioned, is the first requisite of anesthesia. Postoperative nausea and vomiting are frequently increased. Yet, in selected cases I am very partial to scopolamine-morphine administered about an hour before the patient is taken to the operating room (see scopolamine morphine anesthesia, p. [illegible]).

BASAL ANESTHETICS

Hypnotics derived from urea and alcohol which are used for pre-operative medication as well as the anesthetic agent per se are termed basal anesthetics.

Salts of barbituric acid are the most important urea derivatives in popular use. Phenobarbital, allonal and barbital are used mostly as sedatives. Sodium amytal is considered useful as a hypnotic, sedative and anesthetic. The intravenous injection of the barbiturates disturbs the colloidal equilibrium of the

blood; they should be administered orally. The only advantage of the intravenous injection over the oral use is rapidity of action.

The barbiturates do not affect the heart and liver; they produce little toxicity but they may be responsible for a mild form of hysteria. The special advantages gained from using barbiturates are that induction of anesthesia is rather smooth, relaxation of the patient may be obtained sooner, gas anesthesia is more effective and the patient may be prepared sooner. The chief objections to their use are that reflex excitability is increased, respiratory interference is likely to accompany their use, complete anesthesia is almost impossible to attain and the interval during which it is effective is too brief for satisfactory surgery. There seems to be no satisfactory antidote to use in case of an overdose. It is not reliable unless used in conjunction with scopolamine or morphine. For surgery, therefore, its use is limited.

Sodium Amytal

This is marketed in three-grain capsules. One capsule is usually given to the patient the night before the operation and two or three capsules are given a couple of hours preceding the time for which the operation is scheduled. The patient goes to the operating room in a somnolent condition offering no resistance to the anesthesia.

Pernocton

Pernocton is slower in action than sodium amytal. Its effects last longer. Large doses of pernocton are not free from danger. It is recommended only for hypnosis; the amount required to produce this effect is quite safe.

Avertin

Avertin (tribromethyl alcohol) is used quite extensively as a basal anesthetic. It was introduced by Willstaetter and Duisberg of Germany in 1926.

Avertin is packed in 25 and 100 cc. containers after it has been dissolved in amylene hydrate. It crystallizes in distilled water at a low temperature. At 104° F. it decomposes into hydrobromic acid and dibromacetaldehyde; the latter is an irritant which may cause necrosis of the bowel. The dose varies from .06 to [illegible] cc. (60 to 100 mg.) to a kilogram; the maximum dose as a basal anesthetic is [illegible] cc. per kilo ([illegible] lbs.) of body weight.

The equipment necessary for administering this drug consists of an empty container with a stopper which will hold 500 cc., a container of distilled water, a thermometer, a pipette marked in cc., a small rectal tube equipped with a funnel, lubricant, avertin solution, Congo red, a dropper and a glass receptacle for testing purposes.

Step 1. Weigh the patient and determine the dosage by calculating his weight in relation to the drug.

Step 2. Heat the distilled water to 40° C., add the avertin solution, shake well.

Step 3. Test one or two cc. with Congo red. A satisfactory solution is indicated by an orange color.

Step 4. Inject the solution slowly while the patient is lying on the left side. Keep the blood pressure and time of injection.

The usual reaction from the patient takes place in 5 to 10 minutes after the

drug has been administered. Usually a feeling of drowsiness is quickly followed by a deep sleep (in rare instances the patient becomes excited during the administration of avertin necessitating the prompt administration of a general anesthetic). Complete relaxation now follows. A pharyngeal tube may be inserted and in some instances an exposure of the larynx may be obtained. The patient is prepared and if no response is elicited when the towel clamps are applied, the incision may be made. Nitrous oxide or ether may now be administered to complete the anesthesia. The surgeon should always be prepared to do a laryngoscopy and intubation.

After several hours the patient regains consciousness in a very satisfactory manner but until then should be watched for symptoms of approaching asphyxiation.

The use of avertin is not advisable in operations which involve the airways owing to the possibility of postoperative obstruction. Killian reports that avertin does more injury to the respiratory center than either chloroform or ether and that it affects the liver in the same manner as does chloroform.

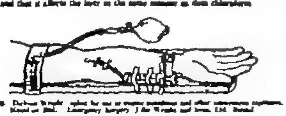


Fig. 63. Dickson Wright's splint for use in evipan anesthesia and other intravenous injections. (Hamilton Bailey: Emergency Surgery. John Wright and Sons, Ltd., Bristol.)

The chief advantages of this drug lie in the fact that it reduces mental shock as well as irritation to the respiratory passages. It does not cause as much coughing as do ether or chloroform and makes postoperative medication unnecessary due to the extended period of unconsciousness.

The chief objections to its use are its high mortality, depression of the respiratory and circulatory centers, acidosis, muscular rigidity, the necessity of constant watchful nursing until the patient regains consciousness and the usual disadvantages of synergistic anesthesia.

Comment. It is a matter of controversy whether or not the reduced quantity of gas-oxygen or ether necessary when used in conjunction with avertin compensates for the disadvantages offered by the drug. Its power to induce anesthesia without the knowledge of the patient as well as its use in acute pulmonary conditions which do not involve the airways are very valuable.

The routine use of avertin or the barbiturates as a preanesthetic is not advocated. Their unpleasant action renders their use unsafe in many operations.

Evipan Anesthesia

Evipan sodium is a preparation of barbituric acid which disintegrates rapidly after it is administered. It is marketed in powder form in ampules

which are accompanied by ampules of distilled water in which the powder is dissolved preparatory to injection. It is injected in the arm of the patient as shown in Figs. 63, 64 at the rate of 1 cc. in fifteen seconds; about 5 cc. usually suffices for a dose. The judgment of the anesthetist must dictate the dose required for a given case. Dickson Wright's splint is of value in administering this anesthetic.

Comment. Evipan anesthesia induces a short, safe period of analgesia which is very desirable in brief operations such as reducing fractures, opening abscesses, etc.

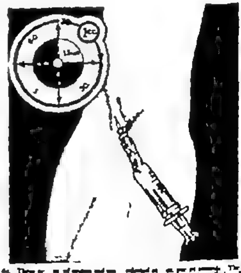


Fig. 64. Three cc. [illegible] of evipan sodium [illegible] injected at [illegible] per [illegible] seconds. The remainder of the appropriate dose [illegible] injected somewhat more quickly. (Hamilton Bailey: Emergency Surgery. John Wright and Sons, Ltd., Bristol.)

It is not recommended in operations requiring more than 15 minutes. No premedication is used and the use of any form of barbiturate is strictly contraindicated. In the case of abdominal operations, however, where muscular relaxation is desired, Jarman and Abel recommend Hoffmann-la Roche preparation containing atropine, gr. 1/75 and scopolamine, gr. 1/150 which may be given an hour before the operation to patients between the ages of 18 and 50.

Evipan anesthesia is contraindicated in patients who have low blood pressure or defective functions of the kidneys or liver.

When an overdose of avertin has been given, strychnine injected intravenously is of value.

Commenting on avertin anesthesia, [illegible] concludes as follows:

The advantages of avertin are:

Total absence of excitement at the beginning of anesthesia. The patient goes to sleep physiologically without the fear of the inhalation mask and [illegible].
Absence of headaches; nausea is much less marked than after ether and vomiting is rare.
3. Abolition of the mask affords an opportunity to operate on the face and mouth with no difficulty.
Complete postoperative amnesia, thus entirely eliminating psychic shock. This is particularly valuable when the anesthetic must be repeated for a number of sittings.
In reference to the advantages over avertin the following may be included:
Minimal drop of blood pressure.
No increased vascularity in the parenchymatous organs.
3. Simplicity of administration; better oxygen may be provided. It is less distressing and affords an opportunity to inject fractional doses.
More prompt awakening as compared with ether.
5. Complete anesthesia without preliminary medication.

Scopolamine-Morphine Analgesia

My experiences with so-called "twilight sleep anesthesia" (scopolamine-morphine analgesia) have convinced me that its judicious use is to be preferred and certainly is followed by better results than with local anesthetics than for used.

The anesthetic action here arises from the synergetic effect of scopolamine and morphine. The patients are carefully examined particularly with reference to the cardiovascular and renal apparatus. They are prepared the day before operation and are kept in a darkened room with absolute quiet enforced. The external auditory canal is plugged with cotton.

Step 1. Three hours before operation a dose of [illegible] gr. scopolamine and [illegible] gr. morphine are injected subcutaneously.

Step [illegible]. The dose is repeated [illegible] hour before the operation.

This dosage is used in patients between the age of fifteen and sixty years. The dose is decreased according to the age of the patient. In those of seventy and over [illegible] gr. of scopolamine is used—not more than two doses. Those patients who have not reached the age of fifteen are not given scopolamine. This form of anesthesia is supplemented by nitrous oxide-oxygen or ether, or a mixture of both, depending upon the type of the case and indications or contraindications in the respective patients. Chloroform is banished from our work. The method is not used in obstetrical surgery.

To obviate postoperative acidosis and relieve the dryness of the oral membranes and throat as well as to replenish the vascular system with fluid, the

[illegible]
[illegible] Critical study of the [illegible] cases of scopolamine-morphine anesthesia. [illegible]

patient is given, directly before he is put to bed, an enteroclysis of 3 quarts of tap water at about 100 degrees F. to which 4 drachms of sodium bicarbonate have been added. In shock, the addition of some brandy is advisable. It goes without saying that when operations are done about the vagina, rectum and perineum, as well as in cases of perforative appendicitis and extensive resection of the lower bowel, enteroclysis is omitted and venoclysis substituted. To avoid excessive distention the colon tube should never be introduced higher than 3 inches in the lower bowel. This is imperative.

Comment. Scopolamine hydrobromide-morphine anesthesia, supplemented by gas or ether as required, is a distinct advance in surgery, and with experienced supervision, perfectly safe.

The failures of earlier observers were due to reliance on scopolamine exclusively as a means of inducing narcosis. Therein lies the danger; and, recognizing the danger it can be forestalled. Chloroform should never be used as an adjunct to scopolamine; nitrous oxide and ether should be given preference.

The advantages of this method of anesthesia are:

1. Suppression of operative fear in the patient.
2. Absolute loss of consciousness.
3. Amnesia as to preparation, etc., incident to the operative procedure.
4. Continuation of sleep four to eight hours after the operation is completed.
5. Elimination of postoperative nausea, vomiting and the harmful straining incident to it.
6. Complete relaxation of the viscera and minimizing the incidence of such unpleasant complications as pneumonia and shock.

The method should never be entrusted to the untrained and the one who gives should supervise and direct the procedure. Occasionally the respirations will be found to drop to six or even four per minute, but, inasmuch as the scopolamine is rapidly eliminated by the kidneys, no ill results will follow if the glottis is prevented from obstructing respirations during the period of complete anesthesia. No complications were observed in our series of about [illegible] cases, and the method was found to be a most excellent one. It is our belief that as an adjunct this method possesses a great many advantages over the usual methods which are practiced today.

ETHER COLONIC ANESTHESIA

This procedure was suggested by Pirogoff in Russia. J. T. Gwathmey popularized and improved the method in this country.

Complete general anesthesia may be obtained by placing a mixture of ether oil and paraldehyde in the rectum of the patient one hour before operation. This form of anesthesia is indicated in operations about the head. A chloretone suppository and hypodermic injection of morphine should precede the administration of this anesthetic mixture.

Gwathmey's Technic. The patient's bowels are kept at rest for 36 hours preceding the operation. The night preceding the operation the patient may be allowed tea and toast for supper. An enema is given two hours later, followed

by two tap-water enemas 20 minutes apart. Complete colonic irrigation is contraindicated. Two hours prior to the operation, a low clear water enema is given. Whenever possible walking is encouraged. The ears of the patient are plugged with cotton, the face covered with a towel and the room darkened.

Step [illegible]. Place the patient in the [illegible] position one hour before operation.

Step 2. Exclude the air from the rubber tubing and catheter to be used, by filling them with warm oil in the funnel.

Step 3. Insert the catheter 6 to 8 inches in the rectum. Permit any fluid or fecal matter to drain out by lowering the funnel. Refill the funnel with oil and exclude all air.

Step 4. Raise the funnel and pour in the remainder of the mixture (warm) consisting of:

Ether		Oil	Paraldehyde
[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
or	[illegible]	[illegible]	[illegible]

This step should consume from 5 to 10 minutes.

Step 5. Now clamp the catheter below the glass connection so that no air escapes. Exert pressure on the perineum with a towel for 5 minutes.

Gwathmey admonishes that great gentleness should be observed in all manipulations and care should be taken to keep the patient quiet at all times. Because this procedure is more of the type of an analgesia than anesthesia, a few drops of ether, nitrous oxide or ethylene may be used to quiet the patient where necessary—never to induce anesthesia.

Danger Signals. Slight cyanosis, dulled lid reflex and stertor. Upon their appearance support the lower jaw or insert a breathing tube. An important feature is the ability to distinguish between analgesia with unconsciousness (usually associated with colonic anesthesia) and surgical inhalation anesthesia with automatic respiration. The superimposition of a third stage inhalation anesthesia on a light colonic anesthesia will result in the patient passing into the fourth or danger zone promptly.

After the patient is returned to bed, siphon off any residue in the rectum. Flush the colon with warm water thoroughly. Following this, 3 to 6 ounces of warm black coffee are instilled and the tube withdrawn. No nausea, vomiting or pain accompanies the final awakening since analgesia continues for some time after consciousness has returned.

Rosenow's technic utilizes very little ether, anesthesia being brought about chiefly by morphine and magnesium sulphate.

Prepare the patient the same as above. An hour before operation, inject intramuscularly [illegible] ampule of:

Magnesium sulphate	[illegible]	gr.	[illegible]
Morphine sulphate		gr.	[illegible]
[illegible]		gr.	[illegible]
Aq. dest.		ad [illegible]	

to be repeated twice at [illegible]-minute intervals (Gwathmey).

After the last injection start a Murphy drip of 8 ounces (240 cc.) of a 6 per cent glucose solution with [illegible] drams ([illegible] cc.) of ether ([illegible] to [illegible] drops per [illegible].)

When the operation is over this solution is discontinued and 1,000 cc. of 6 per cent glucose with [illegible] drams Lugol solution is begun and carried on until it is all used.

The chief advantages of the method are:

It is not depressing.
It is cleaner; it is not necessary to flush the colon afterwards.
3. Less ether is employed.
4. The patient receives nourishment throughout the operation.
5. The anesthetic state continues longer than when [illegible] to 6 ounces of ether are used.

THREATENING DEATH UNDER GENERAL ANESTHESIA

A competent anesthetist manages to have within easy reach at all times, an emergency kit containing (1) adrenalin solution, (2) alpha lobeline ([illegible] gr.), (3) a Record syringe with hypodermic needles and (4) cardiac puncture needles [illegible] in. in length.

Emergency resuscitation is resorted to in asphyxia.

The result of respiratory failure (blue asphyxia).
That due to cardiac failure (white asphyxia).

Type [illegible] is comparatively simple to overcome.

(1) Clear the airways.
(2) Pull the tongue forward.
(3) Administer oxygen, insert [illegible].
(4) Artificial respiration and finally adrenalin.
(5) An intravenous injection of alpha lobeline.

This is usually followed by the desired result.

Stretching of the anal sphincter is often used in these cases if they do not readily respond to other methods.

Type [illegible] [illegible] serious complication requiring prompt, competent aid. Treatment consists of:

(1) Artificial respiration (Figs. [illegible]).
(2) Hot packs about the precordium.
(3) Intracardiac injection of adrenalin and
(4) Cardiac massage

carried out in the order given for fully twenty minutes after the heart has apparently failed to function.

Comment. Fundamental to any effort to avoid impending asphyxia is the elimination of the deadly hinged shock valve, formed when the tongue drops back into the throat; then air can be expired, but all efforts to inspire drive the valve more firmly into its seat.

The best way to eliminate it is by direct laryngoscopy (Fig. [illegible]).

With the patient on his back the direct laryngoscope is inserted backward until it touches the back wall beyond the tongue. Then by a lifting motion the head of the patient is hung up on the cylindric part of the instrument. This brings the tongue away from the back wall of the

allows air to get down back of the tongue into the larynx, and eliminates the deadly lingual check valve.

The bronchoscope is introduced into the larynx and trachea through the laryngoscope. Do not connect the oxygen tube to the bronchoscope until after the oxygen pressure has been regulated, in order to avoid a heavy discharge of oxygen.

Aspiration of secretions through the laryngoscope or bronchoscope prevents the patient drowning in his own secretions.

If means for direct laryngoscopy are not at hand, artificial respiration is the alternative. The best method being the prone-pressure method but

FIG. 65. The death zone. A, Normal position of the tongue; B, [illegible] from the tongue drops backward obstructing the ingress of air. [illegible] started with the tongue in this position, the patient will be [illegible] by the pumping of air out of the lung on the compression stroke while no air can enter on the inspiratory [illegible] the tongue forms a check valve permitting passage in one direction only. For artificial respiration the tongue should be drawn forward with tongue forceps or the fingers covered with handkerchief or gauze but the best way to open up this death zone is with the direct laryngoscope as shown at C. Oxygen and carbon dioxide can then be insufflated. [illegible] every accident ward should be equipped with a direct laryngoscope [illegible] tank of oxygen with 5 per cent carbon dioxide. [illegible] (Courtesy of Jackson and Jackson.)

regardless of the method used, it is necessary to see that the tongue is drawn out and held out.

The necessary equipment for the prevention of asphyxial death that should be in every ambulance and every accident ward is: a direct laryngoscope, a bronchoscope, 5 mm. by 30 cm. of full lumen aspirating [illegible], a tank filled with oxygen containing 5 per cent mixture of carbon dioxide, a piece of rubber tubing, about 4 ft. long attached to the tank outlet.

REGIONAL ANESTHESIA

SPINAL ANESTHESIA

Spinal anesthesia is a form of regional anesthesia used especially for operations upon the lower abdomen and lower extremities in patients who are for any reason unsuitable subjects for general anesthesia. This method affords complete freedom from pain but not from pressure sensation in the operative field. The tissues are absolutely relaxed, the intestines are contracted and do not obtrude upon the abdominal incision. Expulsion of flatus or other content of the bowel is strongly stimulated; there is no toxic action from the anesthetic substance on the heart, liver, kidneys, or lungs and there is no irritation of the respiratory tract.

Although these advantages are great and conceded in the hands of those thoroughly competent and familiar with the technic of its administration, it must be remembered that the administration of spinal anesthesia requires an accurate and very precise technic for uniform results. Accidents in the application of the technic or of the physiologic actions involved, are less capable of being remedied than in other methods of inducing anesthesia, and are more likely to be the cause of fatality. The surgeon performing the operation, if he must accept responsibility for the anesthesia, is more likely to be blamed for a fatality when spinal anesthesia is being used than when anything goes wrong under general inhalation anesthesia. It is said that a very small percentage of cases of spinal anesthesia has been followed by more or less permanent paralysis of the lower limbs, of the bladder or of the anus. This I cannot substantiate as being quite correct from a rather large series of personally observed cases (over [illegible] cases). More or less unpleasant bladder symptoms have followed the use of [illegible] in my hands and in those of Dr. Phil Thorek, but these were of transitory nature. One death resulted at my hands from the use of spinocaine.

After an orgy of trial with all substances recommended for spinal anesthesia, I have returned to novocaine or one of its related allies (procaine crystals or neocaine).

FIG. 66. Spinal anesthesia. [illegible]

Spinal anesthesia may be employed in the case of patients with high blood pressure or for those who have renal insufficiency, but it is not suitable for those with low blood pressure or who are in a state of shock. Neither should it be employed for those with sepsis or those who are running a high temperature, in the case of restless children, nervous individuals or those afflicted with cardiovascular lues.

Although, theoretically, high spinal anesthesia may be employed, yet the possibility of cerebral, cardiac and respiratory complications contraindicate such attempts (Fig. 66).

The most convenient place for injecting the dural sac is generally through the space between the third and fourth lumbar vertebrae. I rarely inject higher than the second lumbar interspace. Gravitation plays a very important part in the movement of the fluid within the subarachnoid space. A fluid of light or

heavy specific gravity may be employed according to the circumstances, and its diffusion in the spinal canal fairly well controlled. Supposing the canal empty, the solution will run downward and collect distally in the sacral region when the patient is placed in the sitting position.

The armamentarium needed for the induction of spinal anesthesia includes a spinal trocar and cannula (Fig. 67) with a sharp point, a glass syringe of 5 cc. capacity to fit the cannula, a hypodermic syringe with a fine needle, the selected anesthetizing fluid and a small quantity of 1 per cent novocaine for cutaneous anesthetization.

FIG. 67. [illegible] for spinal anesthesia.

Commenting on Spinal Anesthesia Complicated by the Breaking of the Spinal Puncture Needle, Louis R. Anderson concludes that:

"Breakable needles made of a good quality steel should be used. The needles should be properly cared for to keep them from rusting. All needles, before their introduction, should be tested with the stylets removed. Care should be taken to prevent any movement of the patient when the needle is in situ.

"When a spinal puncture needle breaks leaving a segment embedded, the site of the puncture should be localized. The patient should be informed of the breakage and the broken needle removed. The localization and the removal of the segment are aided by passing a second spinal puncture needle and by taking anteroposterior and lateral X-rays."

(a) For operations on the upper abdomen, the second lumbar interspace is selected.

(b) For lower abdominal operations and the lower extremities, the second or third lumbar interspace.

(c) For the genital region, the third or fourth lumbar interspace is best.

Failure to obtain anesthesia occurs in from [illegible] to [illegible] per cent of cases. This may be due to failure to enter the spinal canal or to imperfect entrance, to too rapid injection, to insufficient diffusion of the anesthetizing fluid or to obstruction of the spinal canal by tumor, etc.

The dangers to guard against in spinal anesthesia are gulping and nausea which precede a precipitate fall in blood pressure; this is usually due to cerebral anemia and should be combated by lowering the head and chest. Respiratory distress is denoted by cyanosis and shallow breathing. It should be combated by respiratory stimulation methods. Regurgitation vomiting may drown the patient. Cessation of heart action is always fatal if it extends 7 minutes in duration. It calls for cardiac massage, intracardiac injection of adrenalin, or both. Technic. (Figs. 68, 69, 70) The night before the operation sodium amytal [illegible]. On the morning prior to taking the patient to the operating [illegible] administer hypodermically 1/100 grain of hyoscine hydrobromide and ¼ of morphine sulphate. Half an hour before the operation administer [illegible] of ephedrine subcutaneously and immediately after the injection of the

*The Journal-Lancet, Minneapolis, Nov. [illegible]

anesthetizing fluid into the subarachnoid space inject (subcutaneously) [illegible] and one-half grains of caffeine sodium benzoate. In children, the [illegible] and in those suffering from shock, preoperative sedatives should be omitted.

Step [illegible]. The patient is made to sit upon the side of the operating table well back from the edge with his elbows at his side and the forearms crossed in front of the abdomen. The head is then tilted forward until the chin touches the chest. The patient is held by the assistant's left arm which passes around the patient's abdomen.

Step [illegible]. The patient's back is now prepared with iodine and thoroughly sponged with alcohol. A horizontal line connecting both iliac crests will transect the spinous process of the fourth lumbar vertebra. The usual point of injection is just above this line.

FIG. 68. Proper posture in which the assistant places patient for administering spinal anesthesia or lumbar puncture. The vertical line marks the spinous processes. The [illegible] denotes the interspace between the third and fourth lumbar vertebrae.

Step 3. The syringe, piston and the needle which have been sterilized by boiling for ten minutes in distilled water without alkali are made ready for use. While the needle is being introduced a certain sense of resistance is felt which is followed by a sudden "pop" indicating that the needle has entered the subarachnoid space.

Step 4. About 5 drops of cerebrospinal fluid are permitted to escape into the ampule containing procaine or novocaine crystals. These are dissolved and aspirated from the ampule into the barrel of the syringe and then are forced via the needle very slowly into the subarachnoid space. The greater the pressure at which the solution is introduced the higher will be the level of anesthesia. By barbotage is meant the aspiration and reintroduction of the anesthetizing fluid into the subarachnoid space. This may be repeated two or three times; the oftener it is repeated the greater the diffusion of the anesthetic fluid hence the higher the level of anesthesia.

Step 8. The instant the needle is withdrawn, the puncture aperture is dabbed with a little iodine and the puncture point covered with a small square of adhesive plaster or collodion. The patient is now placed in position for operation. The table is quickly tilted so as to lower the shoulders ... inches below the level of the hips.

Comment. A great source of satisfaction is experienced by the surgeon who has an experienced anesthetist at the head of the table to supervise

FIG. 69. Correct posture of patient.

the pulse, respirations and color of the face. Let the anesthetist converse with and encourage the patient and never ask the patient whether he experiences pain; if such be the case he will apprise you quickly enough. Besides, such questions as, "Do you feel this?" or "What do you feel?" will fix the patient's attention to the operation. This is wrong. Instead, blood pressure readings should be taken frequently and thus the patient's attention diverted. When trained assistants are available, I like to supply slowly 5 per cent solution of glucose intravenously while the operation is in progress. Bystanders and operating room personnel must not speak

above a whisper. Wherever possible I refrain from informing the patient as to when the operation is to be performed.

The danger period of spinal anesthesia is from five to twenty five minutes after the injection.

Danger signals are as already stated: marked fall in blood pressure, cyanosis or respiratory depression (irregularity or embarrassment). Premonitory signs are nausea or vomiting. If these persist lower the patient's head further and give 8 to ... drops of adrenalin or ... grain of ephedrine subcutaneously. In young, ... individuals ... drop in the systolic blood pressure to 70 mm.

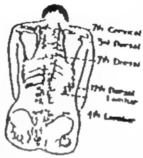


FIG. 70

FIG. 71

FIG. 70. Landmarks of spinous processes.

FIG. 71. Sacral anesthesia. ... The arrow points to the needle ... the operator is directing the needle ... into the canal where the injection is to be made.

may cause no apprehension. ... fall to 70 mm. in an obese ... weakened or aged individual should be immediately counteracted.

Loss of voice is an early sign of respiratory failure. In impending respiratory failure give alpha lobeline hypodermically. Respiratory depression may also be combated by rebreathing of oxygen.

It is preferable to have the patient lie ... 24 hours after operation in the Trendelenburg position and watch for possible untoward symptoms which are combated as they arise.

Headache will sometimes follow the withdrawal of cerebrospinal fluid.

SACRAL ANESTHESIA

Blocking the sacral nerves within the sacrum produces a very efficient surgical anesthesia of the structures these nerves supply. It is highly recommended by surgeons and urologists. ...

This type of anesthesia may be induced by injecting the anesthetic solution into (a) the sacral canal; (b) by paraneural injection of the nerve trunks at

their terminals and (c) by paraneural injections into the posterior sacral foramina. It should be remembered at all times that the fluid is outside the meninges of the spine, consequently this should not be confused with spinal anesthesia.

The apparatus necessary for administering sacral anesthesia consists only of a proper supply of needles and a syringe. The needles should be as fine as stability will permit thus lessening the pain and injury caused by their frequent introduction into the soft tissues. An assortment of needles of different lengths is necessary; they should be made of a high grade flexible steel and have a sharp cutting edge. A small spinal puncture needle which will bend but will not break is used for injecting the sacral canal.

A satisfactory solution consists of ... per cent novocaine solution with 5 drops of adrenalin added to 100 cc. just before using.

Technic. Sterilize the skin surface the same as for other surgical procedures. Place the patient on his abdomen with a cushion under the hips thus raising the buttocks and accentuating bony prominences.

Step 1. With the index finger of the left hand follow the posterior surface of the coccyx upward until the sacral cornua are palpated on each side. The fourth sacral spine may be felt a little higher; this forms the apex of the isosceles triangle which guards the entrance to the sacral canal.

Step 2. Make a dermal wheal within this triangle and infiltrate the subcutaneous tissues and sacrococcygeal membrane.

Step 3. Introduce a fine spinal puncture needle through the skin with bevel upward at a ...-degree angle. After puncturing the membrane and striking the bone of the front wall ... slightly withdrawn, depressed and further used almost parallel to the sacral canal, then direct it slightly upward for a short distance (4 to ... cm.). If blood or spinal fluid escapes, withdraw the needle or change its position until this stops. (Figs. 71-72.)

Step 4. Slowly and carefully inject 5 to 30 cc. of the solution mentioned above. There is no resistance if the needle is properly placed. After half of the amount has been injected slowly withdraw the needle so that at the conclusion its point ... just inside the sacrococcygeal membrane.

If carried out correctly anesthesia of the pelvic floor and viscera usually sequences about 10 minutes.

PARASACRAL NERVE BLOCK

Place the patient in the lithotomy position.

Step 1. Make two dermal wheals at the sacrococcygeal articulation about 1½ to ... cm. from the median line.

Step 2. Introduce a longer needle past the edge of the sacrum anteriorly parallel to the median line and extending to the second sacral foramen. Twenty cc. of ½ per cent novocaine-adrenalin solution is used.

Step 3. Withdraw and direct the needle at an angle anteriorly toward the innominate bone. Thrust the needle deeper until it contacts the promontory of the sacrum near the first sacral foramen. Inject 10 to 20 cc. here. Repeat the procedure on the opposite side. Make a final injection of 5 cc. between the coccyx and rectum.

A guiding finger in the rectum is of great assistance in governing the direction of the needle.

Comment. Paraneural nerve block is a painstaking and delicate procedure which does not always result as successfully as other methods. There is also the danger of puncturing other tissues when inserting the paraneural and of spreading an infection when a septic area is invaded.

TRANS-SACRAL NERVE BLOCK

Step 1. Place a dermal wheal laterally and below the sacral cornu. This determines the position of the sacral notch on the lower border of the sacrum where the fifth sacral nerve lies.

FIG. 72

FIG. 73

FIG. 72. Trans-sacral anesthesia (blocking of the sacral nerves as they emerge from the sacral foramina). The first sacral foramina are usually ... Wheals are made over ... the proposed points of puncture. ... the second sacral foramen ... the fifth foramen ... needles which appear just below and lateral to the cornu of the sacrum (above the fifth foramen). All foramina are equally treated. The method may be useful as an adjunct to high sacral and pre-sacral anesthesia.

Step 2. Ascertain the most prominent point of the posterior iliac spines by palpation and place another dermal wheal 1½ cm. medial and ½ cm. dorsal; this indicates the position of the second sacral foramen. Place two more wheals between the two first made. Place a fifth one above the second at the first sacral foramen. (Fig. 73.)

Step 3. Determine the position of the foramina by inserting the needle downward and slightly inward perpendicular to the contour of the sacrum. Bone is likely to be struck during the first efforts and thus the distance from the skin to the posterior surface of the sacrum is estimated. When the needle has entered to penetrate a membrane but by further penetration does not contact bone, the foramen has been entered. On account of the downward curvature of the sacrum and greater thickness of the overlying soft tissues, the needle should be inclined more in locating the higher foramina. The foramina and nerve trunks decrease in size from above downward making it necessary to inject larger amounts of solution in the higher foramina.

rather simple, while in the case of a large obese individual, it obviously becomes more difficult.

LOCAL ANESTHESIA

Novocaine known in America as procaine is the agent most generally used for inducing local anesthesia. It is safer and less toxic than cocaine.

Procaine may be boiled in normal salt solution and adrenalin, adrenin or epinephrine added after it has cooled to body temperature. Or sterilize a medicine glass and dropper with the instruments. Have a supply of sterile water at hand. Before the operation is begun, drop as many (to 4 two-grain) procaine

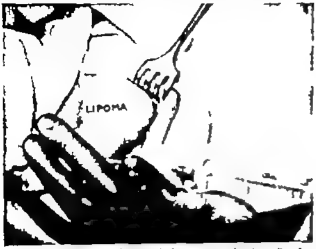


Fig. 85. Exposure of tumor after skin and subcutaneous tissues have been infiltrated.

tablets as previously calculated to be needed for the operation into a medicine glass. Crush the tablets and fill the glass with sterile water. Add the desired amount of adrenalin to the solution. Mix thoroughly. A fresh solution is thus always readily obtainable. The following formula recommended by Fisher is satisfactory:

Procaine	[illegible]
Sodium Chloride	[illegible]
Thymol	[illegible]
Distilled Water	[illegible]

This makes a ½ per cent procaine solution in normal salt solution plus [illegible] gr. of thymol added as a preservative. This solution may be boiled and

Fig. 86. [illegible]

Fig. 87. [illegible]

epinephrine added at the time it is used. Thymol causes a slight stinging sensation when the drug is injected.

The apparatus essential for the administration of local anesthesia consists of a syringe and needles (Fig. 8[illegible]).

Fig. 88. Local anesthesia. Making [illegible] and wheal of infiltration.

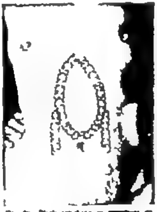


Fig. 89. Block anesthesia in operations on the upper [illegible].

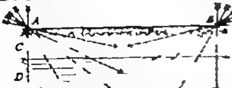


Fig. 90. Diagrammatic representation of base and overlying tissues infiltrated with anesthetic solution. A, B, points of entrance of the needle; C, subcutaneous cellular tissue; D, muscle and fascia; E, bone.

If the operation is to be a prolonged one and the patient of the apprehensive nervous type, a hypodermic injection of ¼ gr. of morphine may be administered an hour or so before the procaine is injected. Hertzler[1] refers to the premedication as "removing the hypertension from the apprehension."

Scopolamine-morphine analgesia may be advantageously combined with local infiltration anesthesia.

[1] Hertzler: Local Anesthesia. C. V. Mosby Co., 1917.

Assurance to the patient and proper suggestion are of inestimable value in local anesthesia. All fears of the patient must be allayed.

TYPES OF LOCAL ANESTHESIA

(Figs. 8[illegible], 8[illegible], 8[illegible], 8[illegible])

Endermic Infiltration. This consists of injecting the papillary layer of the skin where the nerve-endings arborize (Fig. 8[illegible]).

Subdermic Infiltration. Here the injection is given under the skin.

3. Nerve Blocking. Such nerve trunks as the sciatic, brachial plexus, etc., may be blocked first without exposing the nerves. Smaller nerves (intercostal, radial, ulnar, etc.) are often treated likewise. The anesthetizing fluid is injected into the nerves directly as a rule; however in some instances the nerve becomes infiltrated by the diffusion of the agent through the tissues. (Fig. 87.)

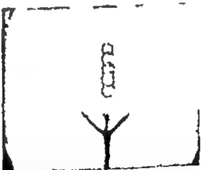


Fig. 91. Infiltration anesthesia for opening the bladder (cystotomy).

Perineural injection is an infiltration of the tissues around the nerve paths and is resorted to in hernia operations, thyroidectomies, etc.

5. Edemization (Schleich's Method). Here also all the tissues surrounding the operative field are injected.

Two or more of the above procedures are usually combined in this type of anesthesia. Endermic infiltration is often used for the skin and some form of nerve-block or edemization for the deeper tissues.

In another method the principal nerve trunk is sought first, necessitating two or more rather deep thrusts of the needle into the tissues, after which the skin is anesthetized.

Descriptions of local anesthesia as pertaining to various operations will be found under the respective operative procedures. (Figs. [illegible], [illegible].)

Part II

SURGERY OF THE HEAD AND NECK AND PLASTIC SURGERY

ORIENTATION

[illegible]

CHAPTER 7

SURGERY OF THE SCALP AND PERICRANIUM

INJURIES

WOUNDS OF THE SCALP

[illegible]

AVULSION OF THE SCALP

While rare, avulsion of the scalp does occasionally occur in industrial plants.

[illegible]

TUMORS

MENINGOCELE AND ENCEPHALOCELE

[illegible]

SEBACEOUS CYSTS (WENS)

Step Shave and prepare the skin aseptically. Use local infiltration anesthesia (1/2 to 1 per cent novocaine) injected around the cystic tumor.

Fig. 91. Temporary hemostasis of the scalp. Fig. 92. Result of scalp wound.

Fig. 93. Partial avulsion of scalp with fracture. Skin grafting. Recovery.

Step Incise the skin overlying the cyst and dissect laterally the tumor overlying. Attempt to remove the cyst without breaking its capsule.

Step 3 Attend to hemostasis. Close wound with interrupted sutures. (Fig. 95.)

If the cyst is infected and suppurating it should be treated as an abscess (drainage). Wherever possible, it is better to excise it thoroughly together with the infected inflammatory structures surrounding it.

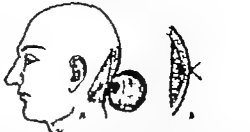


Fig. 96. Occipital sebaceous cyst. A. A dotted line indicates the area of resection of the external membrane of the cyst. B. ... showing ... of the ... and ... of the ... sutured with ... sutures. Deep and ... of ... with clips. (After Dupuy.)

ANGIOMA OF THE SCALP

When nevi of the scalp require removal by operation, the incision should be made sufficiently far from the nevus so that hemostasis may be easily effected. Rapidly growing angiomas which penetrate the subcutaneous tissues or threaten hemorrhage call for prompt operation. Angiomas over the fontanelles often communicate with the longitudinal sinus. Radical operation should here give way to other measures (radium).

Cavernous Angiomas which tend to penetrate the skull should also be treated by radium or electrocoagulation, or by subcutaneous ligation, if surgery is decided upon.

Fig. 97. Hemangioma. (Courtesy of Dr. ... Lahey Clinic ... of Illinois.)

Step 1. Arm a full curved needle with catgut. Pass the needle through the entire thickness of the skin for about 1/2 to 1/2 cm. down to the pericranium.

Step 2. Remove the full curved and pass into a semi-curved needle. With this pass the suture from the point of emergence of the needle back to its point of entry immediately under the skin. Tie the suture tightly.

Step 3. Repeat this all around the nevus until practically every vessel entering or leaving the tumor is controlled. Each suture should overlap to some extent into the territory controlled by the next stitch.

CIRSOID ANEURYSM OF THE SCALP

Operation for cirsoid aneurysm of the scalp is done in two stages, under general or infiltration anesthesia. Place the patient in an almost sitting position; use a tourniquet whenever possible.

Stage I

Step 1. The incision should extend through the skin and epicranial aponeurosis and embrace the cirsoid mass anteriorly and laterally. Make the incision in steps, using compression against the bone on each side of the incision until the vessels are secured with artery forceps and ligated. The main vessels should first be isolated and doubly ligated before being divided. When

Fig. 98. Multiple sebaceous cysts (turban) of the scalp. (Lower.)

completed, this incision outlines a horseshoe shaped flap having its base at the occiput. (Fig. 94.)

Step 2. Reflect the flap from the cranium. This step requires the use of numerous ligatures because of the free anastomosis with the diploic vessels.

Step 3. Place a gauze pack between the flap and the bone. Replace the flap over the gauze. (Bryant.) Apply dressings and bandage.

Stage II

Step After three or four days remove the dressings and excise the tumor. The resulting thrombosis in the blood vessels of the tumor and the lessening of the contiguous connective tissues, the result of edema, now facilitate the excision of the tumor, which should not be done at the first sitting.

Step 4. Replace and suture the flap into position. Drain the wound.

MALIGNANT TUMORS OF THE SCALP

Anatomic Considerations. The lymph vessels of the frontal, and the anterior part of the parieto-occipital regions, drain into the parotid lymph nodes which are situated mainly in the parotid region, their removal involves the removal of the parotid gland. Carcinoma of the scalp with metastases into the parotid ... usually

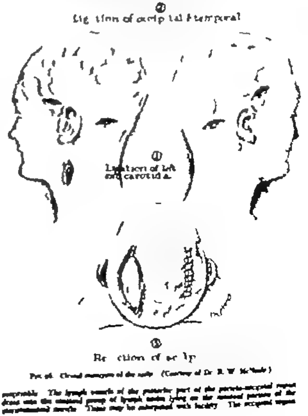


Fig. 98. Cirsoid aneurysm of the scalp. (Courtesy of Dr. R. W. McNealy.)

inoperable. The lymph vessels of the posterior part of the parieto-occipital region drain into the occipital group of lymph nodes lying on the occipital portion of the sternomastoid muscle. These may be extirpated with facility. The occipital region

is drained by two [illegible]. From the lateral part, the vessels unite to form a single trunk which courses downwards to a point under the sternocleidomastoid muscle and here enters one of the external nodes of the sternomastoid group. From the dorsal surface the lymph vessels course to the occipital nodes.

The surgical principles underlying operative procedures here are the same as obtain elsewhere, viz.:

Free excision of the tumor.

Removal of the lymph vessels and nodes draining the affected area, whenever possible.

3. Follow up by radiation.

Technic, Carcinoma Being Freely Movable

Step [illegible] Excise the tumor thoroughly in healthy tissue down to the bone.

Step [illegible] If possible, cover the resulting defect by undermined or [illegible] flaps. If impossible, permit the wound to granulate and later do a skin graft or plastic operation.

Carcinoma Being Adherent

Step [illegible] As above.

Step [illegible] Chisel away the external table of bone underlying the involved area.

When the Diploë Has Been Encroached Upon

Step [illegible] Remove the entire thickness of the skull, [illegible].

Step [illegible] Cover the resulting defect by the Müller [illegible] procedure. In instances where the so-called silent areas of the brain are also involved (frontal, occipital), not only the dura but portions of the cerebral cortex may also have to be removed.

CHAPTER 8

SURGERY OF THE SKULL AND BRAIN

INJURIES OF THE CRANIAL VAULT

SCALP WOUND WITH POSSIBLE FRACTURE

Step [illegible] Enlarge the wound. If only a fissure is seen in the bone and the opposing sides are in good alignment, treat as an ordinary scalp wound.

Step [illegible] If foreign material (hair, dirt, etc.) are within the fissure, enlarge the opening with chisel or rongeur. If this offers difficulties, drill a hole on either side of the crack and chisel away a strip of bone along the fissured line on either side. Thoroughly remove foreign material!

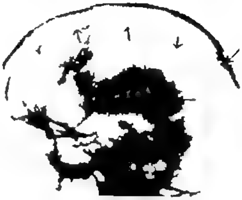


Fig. 9[illegible]. Multiple fractures of the skull causing no symptoms. The patient was beaten over the head with the butt of a revolver during a holdup. No loss of consciousness but severe bleeding from the scalp. After remaining in the hospital for one day patient insisted on leaving stating he felt perfectly well. (From [illegible] American Hospital.)

Step 3. Look for injuries of the dura or hemorrhage; deal with these, if present, accordingly. After completing the operation, close the wound; drain [illegible] sutures.

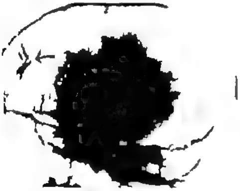
SIMPLE FRACTURE WITH DEPRESSED BONE

Figure 9[illegible] shows deep and multiple fractures of the vault of the cranium which did not produce any symptoms. Occasionally multiple fractures (Fig. 9[illegible]) may be treated expectantly provided the patient can be kept under strict observation.

Whether symptoms are present or not the depression, particularly if marked, should be elevated and the subjacent structures relieved from pressure. The inner

ner table is almost always more extensively damaged than clinical signs would indicate (Fig. 99.)

If operation is decided upon, however, the depressed fragment should be elevated into place by introducing a bone elevator (Fig. 100) into a fissure or an opening made by means of a burr or drill to gain access to the depressed fragment, and [illegible] or, an osteoplastic flap designed to have the depressed bone in the center may be made. When the flap and bone are turned downward, digital pressure or light blows from a hammer will bring the depressed bone into normal



[illegible] Depressed fracture [illegible] skull

alignment. The surrounding areas are now inspected for bone spicules, foreign material or intradural hemorrhage and the flap is replaced. The wound is then sutured in place and a small drain inserted.

COMPOUND COMMINUTED FRACTURE

Step [illegible] Expose the fractured area.

Step 2. Drill holes on either side of the injured bone.

Step 3. Remove fragmented bone. (Figs. [illegible] and [illegible].)

Step 4. Irrigate with hot normal saline solution, washing away debris, blood clots and foreign material (see comments). If the dura is torn, clean it and suture the rent. It is safer to drain than not to drain. Defects in the dura that cannot be repaired should be covered with some aseptic material (foil, cargile membrane, rubber, etc.) or some duraplastic may be resorted to. Injured areas should be packed.

Step 5. Attend to hemostasis. Fragments of bone, if not soiled, may be cleansed and replaced, provided the dura is intact. If not, repair the dura; discard the bone fragments.

Step 6. Close the wound.

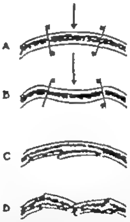


Fig. 99. Local depressed fracture of the vault; the mechanism of [illegible] production. A, the normal vault with its outer and inner table, and the interposed diploe. The arrow indicates the force applied at the point of contact, and the [illegible] are placed at right angles to both the outer and inner tables, [illegible]. B, the force applied at the point of contact [illegible] depression of both the outer and inner tables, and [illegible] of the [illegible] table as shown by the divergence of the lines [illegible] and [illegible]. C, the inner table may fracture and [illegible] only be depressed, and yet the outer table may remain intact, either depressed or [illegible], as the [illegible] position. D, [illegible] depressed fracture [illegible] the force applied [illegible] fracture not only at the point of contact but also at the margin of the depressed area, the line of fracture of the inner table [illegible] always beyond that of the outer table. (After [illegible].)

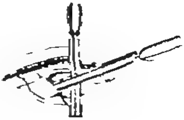


Fig. 100. Method of elevating bone fragments [illegible] depressed fracture [illegible].

Comment. At all cost, make sure that nothing is left behind in the wound that may cause disastrous results. If in doubt, make a trephine hole

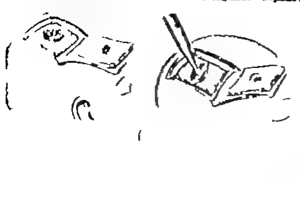


Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Injury to bone substance, splinters of bone in brain.
Fig. [illegible]. Removal of splinters of bone from brain substance. (Adson-Thorek: Surgery of the Brain and Spinal Cord, F. J. Rebman Publishing Co.)

lateral to the fracture. Explore. Do not exert pressure on the fractured fragments in any operative maneuvers lest injury result to the underlying

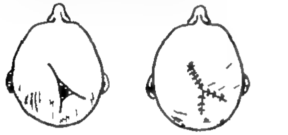


Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Cushing tripod incision for wound of the scalp with loss of substance.
Fig. [illegible]. Same incision. Wound sutured.

cerebral structures. A wise rule to adopt in cranial fractures, whether depressed or not, is: When in doubt, explore!

PENETRATING WOUNDS OF THE BRAIN

Step 1. Make a Cushing tripod incision (Figs. [illegible] and [illegible]).
Step 2. Remove the area of cranial penetration en bloc instead of piecemeal. Bore four holes with a burr or very small trephine outlining a quadrangular area on the outer boundaries of the involved cranial space.
Step 3. With the aid of a Gigli saw remove this square of bone carrying the penetrating missile wound. Trim away the lacerated edges of the dura.

Fig. [illegible]. Removing fragments in penetrating wounds of brain by suction. (Cushing.)

Step 4. Pass a rubber catheter down to the depths of the wound; do not explore with the finger. The distal end of the catheter is attached to a hand suction bulb or an aspirating syringe through which bone particles of debris are aspirated or washed away (Fig. [illegible]). Do not attempt to remove bullets unless freely accessible.
Step 5. Close the wound. Drain.

Comment. Bullets entering the cranial cavity may produce death, a great deal of mischief or minimal damage. All depends on the location of the missile. A flat x-ray plate (Fig. [illegible]) does not give sufficient information as to the exact location of the bullet. Stereoscopic plates and special methods of localization must be employed by the roentgenologist to locate the position of the bullet accurately. If no symptoms are produced by the bullet, leave it alone. If it gives rise to clinical manifestations, remove it.

CONCUSSION OF THE BRAIN

Do not rush the patient to the x-ray room. Get him out of shock first. After shock is combated, get stereo-x-rays to ascertain the presence or absence of fracture and its location.

Masterly inactivity—so aptly expressed by Hamilton Bailey—should be the slogan. Good nursing is here superior to medical meddling.

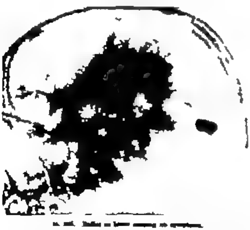


Fig. [illegible]. Bullet in brain causing no symptoms.

METHODS OF REDUCING INTRACRANIAL TENSION

1. Magnesium Sulphate. If the patient is conscious, one half ounce of a saturated solution of magnesium sulphate is given every two hours for twenty-four to forty-eight hours (Hamilton Bailey). Reduce the dose gradually until the seventh or tenth day, then discontinue it. Give no water during this treatment to avoid excessive catharsis. Restricted quantities of barley water, fruit juices and broth are allowed. No catharsis will result when the water intake is restricted.

   If the patient is unconscious give magnesium sulphate per rectum (six Gm. dissolved in 100 Gm. of water) administered by rectoclysis and repeated every four hours.
2. Hypertonic Saline Solution by Venoclysis. This is to be used only in desperate cases (50 cc. of a 30 per cent solution). See that none of the solution finds its way to the contiguous structures lest pain and sloughing result.
3. Lumbar Puncture. Abstract slowly about 8 to 10 cc. of cerebrospinal fluid through a needle reaching the subarachnoid space between the third and

fourth lumbar vertebrae. Repeat the procedure within 24 hours, if necessary. Let the spinal fluid pressure be your guide.

Malone warns against attempting to decompress by any method, if the blood pressure is below normal.

FRACTURES OF THE BASE OF THE SKULL

Treat as concussion.
Where cerebrospinal fluid escapes give sucrose intravenously (Type) (50 cc. of a 50 per cent solution).
Plug the nares or ears to avoid infection.

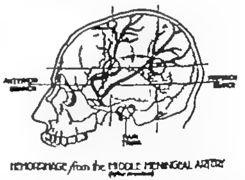


Fig. [illegible]. After injury of the anterior branch of the artery ... [illegible] ... in the frontotemporal region. After injury of the posterior branch, in the parieto-temporal region. After injury to the main artery, low down in the temporal region. The ... [illegible] ... where the trephine opening should be made.

3. Treat symptoms as they arise.
4. Increased intracranial pressure is combated by one of the methods outlined under concussion.
5. The force of subtemporal decompression for fractures at the base of the skull (unless definitely indicated) is fortunately passing, except, of course, in definite hemorrhage from the middle meningeal artery (see below).
6. Restlessness is relieved by morphine or paraldehyde (rectally).

INTRACRANIAL BLEEDING

Be familiar with the anatomic position of the middle meningeal artery and its branches. The question to be decided is: Where is the hemorrhage? Is it extra- or intradural? When in doubt and when the condition of the patient is growing worse—explore.

Step 1. Open the skull by any of the methods described on p. [illegible]

Step 8. If the operation fails to reveal any large collection of blood, do a subtemporal decompression (p. [illegible]).

Step [illegible]. If bleeding from the middle meningeal artery—trephine in the middle of the temporal region, fairly low down, to expose the main branch of the artery.

The common trunk of the middle meningeal artery or the anterior or posterior branch is usually ligated. The locations of hematomas were studied by Kronlein and are shown together with the points for trephining in (Fig. [illegible]). Then complete the operation with A, B or C (see below).

Last Step. After the skull is opened, wash away clots, search and find the bleeding point and ligate it. Be thorough.

(A) Ligation of the Trunk of the Middle Meningeal Artery

There are no fixed relations between any point of the middle meningeal artery and its branches. The main trunk enters the cranial vault through the foramen spinosum.

Step 1. Select as center for the trephine opening a point that will fall over the artery proximal to its bifurcation, generally about 3.8 cm. behind the external angular process of the frontal bone and [illegible] cm. above the zygoma.

Step 2. Incise and retract the skin and soft parts. Incise the superficial temporal artery and vein, guarding the auriculotemporal nerve and branches of the facial nerve.

Step 3. Carry the incision along the posterior border of the temporal muscle through the periosteum to the bone.

Step 4. Apply the trephine, remove the disc of bone, expose the meningeal artery and ligate it after removing all clots, examine the dura mater and suture the lacerations present, after removing any bone splinter or other loose tissue. Irrigate the region thoroughly.

Step 5. Close the various layers of the wound in the usual way.

(B) Ligation of Anterior Branch

Step [illegible]. Select as center of the trephine opening a point about 3.8 cm. behind the external angular process of the frontal bone and 3.8 to 4.5 cm. above the zygoma.

Step 2. Make a horseshoe incision, with its center over the above point and its convexity upward, the outer limb being just behind the external angular process. The incision is carried through the skin, temporal fascia, temporal muscle and periosteum to the bone. The soft parts are retracted downward.

Step 3. A [illegible]-inch trephine is applied at the point selected and the further steps in the operation are practically the same as for ligation of the main trunk of the middle meningeal artery.

(C) Ligation of the Posterior Branch Through Trephine Opening Exposed by [illegible] Incision

Step 1. As before, a point is selected as trephine center which will fall over the posterior branch of the artery at the groove of the parietal bone, which is taken to be at the intersection of a line drawn horizontally backward on

level with the roof of the orbit and one drawn vertically upward from directly behind the mastoid process [illegible] the point just below the parietal eminence.

Step [illegible]. Make a horseshoe incision, as previously described, with its center over this point, the limbs being from 5 to 7.5 cm. apart.

Step 3. The operation is now performed in general as in the operation on the anterior branch of the artery.

Where an Intradural Clot Is Suspected

Step [illegible]. Incise the dura, or make a dural flap with its base directed upward.

Step [illegible]. Irrigate the clot away with saline solution under gentle pressure.

Step 3. If pial vessels are bleeding, ligate them with fine silk carried on curved needles.

Step 4. Gently raise the temporal lobe and explore thoroughly. Wash away clots. If both sides are injured and similar conditions suspected, bilateral exploration should be done.

Where no bleeding is found, do a decompression. It will bring relief (the case may be one of multiple small hemorrhages in and about the brain).

BRAIN ABSCESS

Joseph E. J. King, having observed that the vast majority of abscesses approach the dura to within [illegible] to [illegible] cm., has developed the following operation, the technic of which is relatively simple and which has proved very safe in his hands ([illegible] out of [illegible] recovered). If possible no attempt should ever be made to drain an abscess until it is encapsulated, a process requiring several weeks.

Step [illegible]. Local anesthesia, novocaine [illegible] or [illegible] per cent solution with epinephrine alone or combined with avertin. In adults, especially those that are stuporous or in a semicomatose condition, local anesthesia alone will suffice. In children, the combination with avertin is more satisfactory.

Step 1. Incision. In temporosphenoidal abscess a short, straight, slightly oblique incision about [illegible] inches long is made through all the soft parts down to the outer table of the skull. An opening with a [illegible] drill is made at a point about [illegible] inch posterior to and about [illegible] inches above the external auditory meatus. This latter is enlarged to a [illegible] incision if such has not already been made.

In frontal lobe abscess, there is usually little brain substance intervening between the abscess and the posterior wall of the frontal sinus or ethmoids. An osteoplastic flap is turned down with incisions along the eyebrow, hair line, and center of the forehead. The flap is turned under and sutured so [illegible] until such later time as it is replaced.

In cerebellar abscess the approach, in the absence of a mastoid incision, made behind the lateral sinus and should be preceded by ventricular puncture.

In metastatic abscess, incision is through the scar on the skull.

Step 2. A blunt catheter is inserted through a nick in the dura and the abscess wall found (not punctured) and outlined by repeated probes of the catheter. The incisions (in temporosphenoidal abscess) are enlarged to expose the pericranium over an area 3 by 4 cm. in diameter. An opening is made in the outer table of bone [illegible].

table, the dura stripped back to within [illegible] inch of the bony defect and the cortex fixed to the dura, and the dural margin, meninges and cortex fused by electrocoagulation.

Step 4. The overlying brain substance is removed by electrocoagulation and the necrotic material by suction.

Step 5. A small amount of abscess material is removed by aspiration to relieve tension, then the upper presenting portion of the abscess opened with the electrosurgical needle and the pus evacuated by suction. Remaining flakes of pus are removed under direct inspection. There is continuous elevation of the floor of the abscess toward the level of the skull beginning with the operation.

Step 6. Two layers of [illegible] gauze are introduced into the abscess cavity and held snugly against the wall by strips of [illegible] gauze. The open end of a small rubber irrigating tube is carried within the overlying gauze and a wet [illegible] gauze dressing applied and held with a bandage.

Step 7. After-treatment. Instillation of [illegible] solution is made every two hours. The superficial dressings are removed after 48 hours. The narrow gauze strips are gradually removed, so that by the tenth day the floor of the abscess is level with the skull (too rapid herniation is controlled by lumbar puncture) when the gauze can be entirely removed, care being taken that, if [illegible] is adherent, the brain substance is not removed. Epithelialization is rapid. Months or months later a scalp plastic may be done to give better protection.

Comment. In lateral lobe abscess at the medial anterior portion, [illegible] to the anterior horn of the lateral ventricle, collapse almost immediately after evacuation will make it difficult to insert anything into the cavity without injuring the wall. [illegible] method where wire loops covered with a perforated rubber glove finger will serve to hold or guide the flow of the cavity to the surface and prevent collapse and subsequent pocketing.

In cerebellar abscess the abscess wall usually will be evident at the point incised and taper toward the brain so that Dakin-tube-size drainage tubes with lateral perforations can be inserted without danger of a secondary pocket after collapse. The wound is loosely packed with [illegible] gauze about the tubes. The tubes are irrigated with [illegible] solution and allowed to remain in position about three weeks, then are gradually shortened.

In metastatic abscess, lumbar puncture can be safely done during operation when the cortex is already fixed to the dura. During withdrawal the abscess cavity enlarges so that it can be inspected directly. The cavity is then packed with [illegible] gauze or plain gauze dipped in [illegible] oil.

OPERATIONS ON THE SKULL AND BRAIN (GENERAL)

Study of the Patient. The patient who is to undergo an operation on the head should be subjected to an examination by a competent neurologist and oculist whose guidance in the matter of diagnosis and suggested therapy is of

equal importance to the surgeon's skill. The patient should be under observation in the hospital as long as is necessary to marry all [illegible] conclusions and the general condition of the patient brought as nearly as possible to par.

Preparation for Operation. The day before the operation the whole head should be shaved and the surgical localization outlined with carbol-fuchsin or an alcoholic solution of brilliant green.

After the patient is under the anesthetic and on the operating table, full strength tincture of iodine is applied to the entire scalp. After this has dried, it is removed with a [illegible] solution of alcohol. (I prefer not to remove the iodine.) Opinions differ as to the manner in which the skin should be prepared. Some prefer to paint the scalp with tincture of iodine; others prepare the field with tincture of green soap and water followed by alcohol and ether or tincture of iodine. As a matter of fact, it does not matter which method is used as long as it is thorough.

Fig. [illegible]. Position of patient for suboccipital craniotomy.

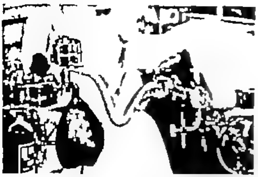
Position of the Patient on the Operating Table. The patient should be placed securely on the table. The positions are best comprehended by perusal of the illustrations.

It is of importance that the patient be comfortably placed, that there is no interference with respiration and that the surgeon is afforded free and convenient access to the field of operation.

For temporofrontal and frontal operations, the patient should be flat on his back. If lateral or [illegible] exposure is aimed at, the patient is placed on his side and sandbags are used to elevate and steady the head to keep it from rolling from side to side.

For operations on the occipital lobes or cerebellum, the patient is usually placed with his face down. The forehead is placed on a stand near the operat-

table or on an adjustable headrest and large sandbag is placed under each shoulder to facilitate separation (Figs of rag)



F Fig. Anesthesia position of patient for operations on the cerebellum.

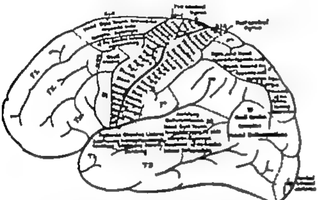


Fig. 10 Diagram of the external surface of the brain to show the localization of movements as mapped out by electrical stimulation (after Foerster

CRANIOCEREBRAL TOPOGRAPHY

This plays an important role in cerebral surgery There are many methods of cerebral localization in vogue (Fig 10) Since larger incisions and larger flaps are made nowadays than was the practice formerly mistakes in determining the exact site of the lesion are offset by adequate exposure. The skilled

surgeon readily orients himself on the cerebral cortex However if it is desired to locate some certain part of the cerebral hemisphere, the flap may be replaced and the outlines observed in their relation to the surface of the brain

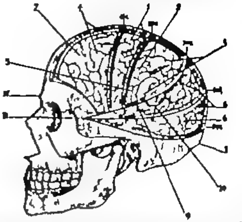


Fig. Chipault craniocerebral topography. N nasion or nasofrontal suture, I inion or external occipital protuberance, R retro-orbital tubercle, [illegible] precentral point, [illegible] Rolandic point, [illegible] Sylvian point, [illegible] temporosphenoidal point, [illegible] lateral sinus point, motor and sensory disturbances, lower extremities, motor and sensory disturbances, upper extremities, motor and sensory disturbances, face, tongue, [illegible] motor aphasia in right-handed people and vice versa, (a) movements of the body (posterior part of the first frontal), (b) movements of the head and neck (posterior part of the second frontal) (c) associated movements of the eyes and head, [illegible] [illegible] and word blindness, [illegible] [illegible] [illegible] (motor, lingual lobe and calcarine fissure, which [illegible] [illegible] between the [illegible] and [illegible] points), [illegible] (first tem) [illegible] [illegible] The [illegible] [illegible] The [illegible] [illegible] [illegible] occipital convolutions, are between the [illegible] and [illegible] lines.

I prefer Chipault Method because it is not difficult to remember It is easy to execute and is accurate regardless of the type of individual (tall, women, negro etc).

THE CHIPAULT METHOD OF CRANIOCEREBRAL LOCALIZATION

The metric system is recommended for making the measurements. The distance is measured from the nasion, over the groove under the glabella, over the sagittal suture, ending at the inion (Fig 11) Measuring from before backward, the following percentages are indicated

1. 45 per cent—the precentral point
2. 55 —the Rolandic point.

3. 70 per cent—the Sylvian point
4. 80 —the temporosphenoidal point
5. 95 —the lateral sinus point

A small prominence opposite the external canthus of the eye, beneath the external angular process of the frontal bone, on the posterior border of the upper part of the frontal process of the malar bone is identified as the retro-orbital tubercle

The position of the Sylvian fissure is determined by drawing line from this tubercle to the 70 per cent point this line is divided into ten equal parts

The second and third tenths are joined by line to the 45 per cent point which denotes the precentral fissure.

The Rolandic fissure is marked by line joining the third and fourth tenths to the 55 per cent point

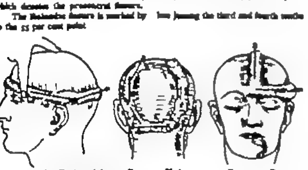


Fig. 112. Block infiltration of the scalp (circumferential) Fig 113 Block infiltration of the scalp (circumferential) Fig. 114. Frontofrontal block infiltration of the scalp.

The superior temporosphenoidal fissure is indicated by the junction of the retro-orbital tubercle to the 80 per cent point

A line from the retro-orbital tubercle to the 95 per cent point indicates the lateral sinus, posteriorly

For the purpose of minute localization, the above lines are divided into tenths

The second tenth of the three main lines is traversed by the anterior branch of the middle meningeal artery

By introducing the exploring needle in the superior temporosphenoidal convolution at the junction of the third and fourth tenths on this line at depth equivalent to one-third of the transverse diameter of the brain here, the posterior portion of the lateral ventricle may be tapped

If it is desirable to explore the descending horn, the needle is placed in the middle temporo-sphenoidal convolution immediately over the external auditory meatus

ANESTHESIA IN CRANIOCEREBRAL OPERATIONS

In England and on the Continent, chloroform seems to be the popular form used in operations on the brain In America ether or novocaine-

suprarenin analgesia is given preference I never use chloroform; it lowers the bloodpressure and while it is true that ether raises the bloodpressure and thus favors oozing, it is on the whole, safe A trained anesthetist is indispensable in these operations Oxygen and facilities for artificial respiration should be at hand The bloodpressure should be taken at stated intervals.

Operations of this type which are performed in two stages require anesthesia for the first stage only—it is not essential to anesthetize the patient for comp[l]eting the dura and brain after the osteoplastic flap has been lifted.

Intratracheal or hypopharyngeal insufflation anesthesia works well here, particularly have the patient placed in the prone position (face downward) with the head projecting over the end of the table The anesthetist, in such cases, seems to administer the anesthetic from below In removing tumors of the scalp or in decompression operations, block infiltration may be used as depicted in Figs 112, 113, 114

FORM OF BONE FLAP

Usually the flap is of trapezoid shape and located where the vascularity is ample In unusual instances, the base of the flap may be anterior, receiving its blood supply from the supra-orbital and frontal arteries or may be posterior and receive its nourishment from the occipital artery

The size of the flap varies depending upon the requirements of given case and should be sufficiently large so that the various steps of the operative procedure may be accomplished with as little handling of the brain as possible. Certain cases require two flaps for instance where the defect is situated near the median line each flaps should be placed symmetrically and inert about cm from the midline.

CONTROL OF HEMORRHAGE

Hemorrhage from the Scalp

Tourniquet Bleeding controlled by tightly drawing circular tourniquet which consists of rubber band or tube around the head over the supra-orbital ridge externally extending it far down over the temporal fossa and immediately beneath the occipital protuberance posteriorly A sterile towel or gauze bandage is placed under the tourniquet to prevent it from slipping

A pneumatic tourniquet may also be used this consists of rubber tube equipped with check valve which inflated with air after being placed in position.

The drawbacks of the tourniquet method of controlling hemorrhage are: (a) intrusion upon the field of operation (b) tendency to cause venous oozing, if the tension is not quite right and (c) interference with the flap when it is being turned down

Clamp and Suture Incise boldly all tissues down to the bone, after the assistant has exerted firm pressure with both hands laterally The bleeding points are caught with artery forceps. Catgut sutures on curved needles are placed in the tissue surrounding the clamp and tied on both sides

Heidenhain's Continuous Hemostatic Suture (Fig 115) A curved needle is armed with catgut or silk and is passed through the entire thickness of the scalp surrounding the field of operation down to the bone about cm outside

side the site planned for the incision. The stitches are overlapped in such manner that the entire blood supply of the scalp is compressed. These stitches are removed after the operation is completed and the flap sutured in place.

Kredel Plates. These plates have notched ends and their upper surface is furrowed (Fig. 16). A deep suture extending to the bone about the length of the plate is placed so as to compress the tissues between the suture below and the plate above. The plates are applied to both sides of the intended incision. The object, obviously, is the same as in Heidenhain's [illegible] method, which, in my opinion, is simpler to execute.

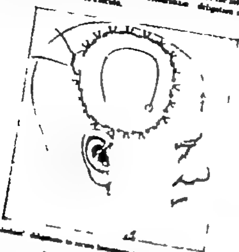


Fig. 15. Heidenhain's [illegible] to secure hemostasis in operations on the skull and brain.

Hemorrhage from the Bone

Horsley's Bone Wax applied to the bleeding point with the finger or on a piece of gauze or some flat instrument has been found most efficacious for controlling hemorrhage from the bone. A segment of adjacent muscle may be used in the same manner.

Crushing the bone or biting it away with rongeurs often controls bleeding from the bone.

Pieces of sterile wood (such as a toothpick) or Krause's hooks (Fig. 17) may be used to advantage.

Hemorrhage from the Dura

This is controlled by using fine catgut or silk ligatures on each side of the bleeding point, carried on fine curved needles. In passing the needles care should be exercised not to injure the underlying cortex cerebri.

If a vessel intervenes in the line of incision, lift the flap of dura in front, if followed, secure the vessel, ligate it doubly and divide it between the ligatures.

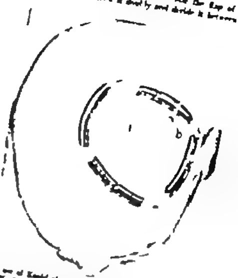


Fig. 16. The use of Kredel plates for hemostasis [illegible] (Kirschner, [illegible] Thorek, Surgery of the Brain and Spinal Cord. J. B. Lippincott Publishing Co.)

In securing the vessel, pass the needle from within outward. This tends to prevent injury to the cortex. Transfixion is essential to prevent the ligature slipping. Silver clips may be used to advantage. Electrosurgical hemostasis has in many cases given me great satisfaction. The technic consists of grasping the vessel with a fine pointed hemostat and touching the latter with the electrode of a diathermy apparatus. Prompt fusion of the vessel wall causes hemostasis.

Fig. 17. Krause's bone hooks for bleeding [illegible]

Hemorrhage from the Cortical Brain Substance

Bleeding is frequently arrested by placing over the bleeding point a small piece of muscle and leaving it in situ. The use of a small piece of absorbent cotton or gauze impregnated with adrenalin solution or a piece of Cargile membrane are also frequently useful in effecting hemostasis.

Cyanosis encourages bleeding. Should this supervene administer oxygen and raise the head of the patient. These measures will tend to check bleeding.

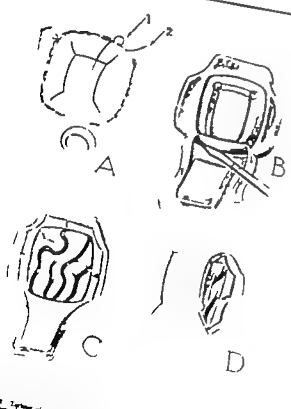


Fig. 18. [illegible]

Hemorrhage After the Removal of a Tumor

This usually comes spontaneously [illegible] the contiguous brain substance filling the space occupied by the tumor. Should bleeding continue, packs of [illegible] gauze, a large piece of muscle with fascia attached, or a large piece of fascia may be packed down into the space previously occupied by the tumor. These will arrest the bleeding. Muscle or fascia-muscle strips may be obtained from the outer surface of the thigh and if their need is anticipated, they should be prepared before the operation on the brain is begun. In clean cases most drainage and packing. Hemorrhage should be controlled before the flap is replaced. Internal pressure may reduce when the flap is pliable.

Fig. 19. Prehistoric skull showing healed trephine openings. (From the collection of Prof. [illegible])

METHODS OF OPENING THE SKULL

Trephining

Trephining may be indicated in several conditions, the most common of which are intracranial tumors, fractures and intracranial suppurations. In some of these cases, patients may be relieved of distressing symptoms such as persistent vomiting, cephalgia and impaired vision due to the presence of the tumor. Decompression operations may be performed in any portion of the cerebral or cerebellar region. However, it is most frequently performed in the temporal region. A valve formation is sometimes resorted to in certain decompression operations (Fig. 18).

The use of the surgical instrument known as the trephine to remove a piece of the skull to give access to the cranial cavity or its products is a very ancient procedure. It was known in ancient times, or at least, certain methods of cutting and removing the bone were in practice (Fig. 19).

The modern surgical trephine is merely [illegible] hollow steel cylinder the lower end of which is provided with [illegible] saw edge (Fig. [illegible]). T[illegible] keep the saw edge in

Fig. [illegible]

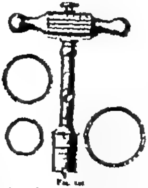


Fig. [illegible]

Fig. [illegible] Serrated trephine and bone drill. [illegible] pattern with one small trephine, four burrs and bone drills.
Fig. [illegible] Galt trephine.

position on the skull, [illegible] pin projects through the center of the cylinder about one-sixteenth inch beyond the cutting edge; this pin is withdrawn as soon as the trephine has cut [illegible] groove in the bone sufficiently deep to keep the trephine from slipping.

In the United States the Galt trephine (Fig. [illegible]) is principally used, the general construction being the same as in that just described except that the cutting part of the instrument is shaped like [illegible] truncated cone. There are numerous electrically operated trephines. A most useful instrument is Prof. Jentzer['s] trephine (Fig. [illegible]). It is distinctly superior and offers many advantages over hand trephines and those operated by electricity. The circular fragment of bone removed by the trephine may be reimplanted and its reunion expected to proceed smoothly. The pericranium is not sacrificed but permitted to remain attached to the cutaneo-muscular flap. Its circulation is thus assured. Jentzer prefers local anesthesia for trephining. A small or large opening may be produced with his instrument at will, the latter by contiguous trephining, or the small

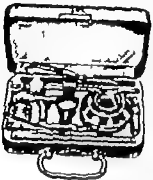


Fig. [illegible] The Jentzer trephine in carrying case.

trephine may be used to create [illegible] small opening and the operation completed with the Gigli saw. Jentzer as did others, successfully used this trephine in [illegible] variety of conditions (simple and subtemporal decompression, removal of tumors of the cerebral hemispheres, hypophysis, etc.).

The component parts of the Jentzer trephine are shown in Fig. [illegible]. The case and instruments may be sterilized in an autoclave, after which the parts are arranged on [illegible] small table. T[illegible] assemble screw the handlers ([illegible]) into the

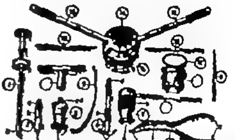
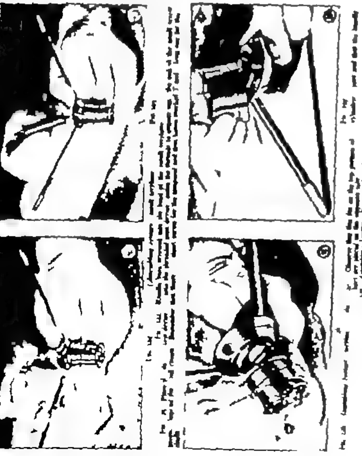


Fig. [illegible] The components of the Jentzer trephine. [illegible]

head of the small trephine and automatic spring. Place the short screw ([illegible]) in the threaded cross device (Fig. [illegible]) and cause the threads to engage until the end of the small screw projects beyond the small crown.

Figures [illegible] depict and describe the procedure for the large or median sized trephines.

Force should not be used when the instrument is being assembled. All the screw channels are threaded with such precision that they function perfectly



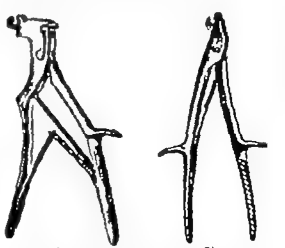
Slight greasing with sterile vaseline will protect the screw channels. The instrument is cleaned with the special instrument shown in Fig. [illegible]

Sterilization is done as stated in an autoclave, in alkaline water (1% sodium carbonate, Na_2CO_3)

TECHNIC OF TREPHINING

Step 1. Mark on the external surface of the cranium the portion the trephine is intended to remove.

Step 2. Form a scalp flap by [illegible] semicircular incision encompassing the marked area, the base of the flap being toward the base line of the skull. The soft tissues of the scalp should be, as stated, incised down to the bone.



(a) (b)

Fig. [illegible] (a) De Quervain [illegible] skull cutting forceps. (b) Hudson [illegible] Rongeur forceps.

Step 3. Detach the pericranium from the bone, the whole of the flap being then turned down and held out of the way. Hemostasis should be attended to.

Step 4. Select [illegible] trephine of suitable size. Introduce the center-pin and place it on the center of the piece of bone it is desired to remove. By [illegible] series of to-and-fro movements with the hand, the teeth of the trephine are made to cut [illegible] circular groove in the bone. When the groove is sufficiently deep, lift the trephine and remove the central pin. Introduce the instrument again without the pin and saw through the circle of bone gradually. Lift the trephine out of the groove occasionally [illegible] and brush out the accumulated particles of bone. Do not saw the bone quite through but by side-

[illegible] [illegible] the trephine [illegible] the opening is nearly complete. Jiggle the piece of bone up or lift it out with a periosteal elevator or similar instrument. If the resulting opening made is insufficient in size enlarge it with appropriate rongeurs (Fig. [illegible]).

Fig. [illegible] Step [illegible] Boring hole in the skull with the perforator.

Steps of [illegible] Trephining

Step [illegible] (Fig. [illegible]). Select the place for trephining. Bore a hole in the skull with the perforator ( ) using its blunt end.

Fig. 130. Step 2. Screwing the pointed small trephine into the opening previously made.

Step 2. (Fig. 130.) Screw perpendicularly into the opening thus made, aided by the key (a) the mounted small trephine, until fixation results. Have this fixation firm (an additional quarter or half turn of the screw will accomplish the desired result).

Step 3. (Fig. 131.) Remove the key (a). Grasp the hand-bore; this is usually

accomplished without effort, and trephine until the segment of bone is automatically released.

Step 4. (Fig. [illegible]) Unscrewing the small round piece. Replace the key (a) using the special bone forceps (bb) as illustrated. The short screw device

Fig. 131. Step [illegible] The key has been removed. Trephining is done until bone segment [illegible] released.

(cc) is also tightened with the key (a). The round section is now unscrewed. Have an assistant hold the instrument while you loosen the round section.

Step 5. (Fig. [illegible]) With the dura separator separate the dura mater from the bone through the opening created in the skull.

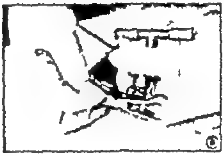


Fig. 132. Step [illegible] Unscrewing the small round piece.

Step 6. (Fig. 134.) Remove any bone spiculae with the special bone forceps (bb). This is an important step if one wishes to use the larger threaded [illegible] device (y).

Step 7. (Fig. 135.) Introduce the socket stem (b). Hug the lower surface of

Fig. 133. Step 5. Separating the dura with the dura separator.

Fig. 134. Step [illegible] Removal of bone spiculae.

Fig. 135. Step 7. Insertion of socket stem (b).

the skull bone. In case of fracture, place the socket stem perpendicularly, in relation to the line of fracture as seen in the accompanying illustration.

Step 8. (Fig. [illegible]) Screw the threaded [illegible] device (y) by hand on to the socket stem until fixation of the stem results.

Fig. 136. Step 8. Screwing the threading [illegible] device (y) on the socket stem (b) until fixation [illegible].

Step 9. (Fig. 137). The large crown mounted with hand bore and spring is now screwed over the external thread of the threaded [illegible]. Never force the adjustment of the thread—you will ruin it. Handle [illegible] gently.

Fig. 137. Step 9. Mounting large crown over the external head of the threaded [illegible]. Do not force! Force threads to engage gently.

Step 10. (Fig. [illegible]) The trephine is now ready for work. Trephine in the same manner as [illegible] using the small trephine. [illegible] [illegible] toward the brain but rather direct the instrument toward one self. The arrow indicates the direction of the trephine. If this admonition is violated the protecting springs will break.

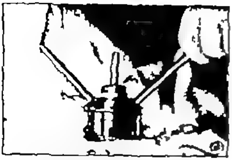


Fig. 138. Step 10. Trephine ready for work. Observe proper direction of trephine (arrows in Fig. 138). Do not push trephine onward (toward the brain)—merely pull toward you.

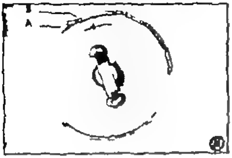


Fig. 139. View of trephined area showing how injury to the dura is avoided.

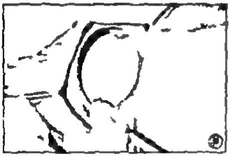


Fig. 140. Bone fragments in trephined area. Remove these with the special bone forceps (Figs. 127 B) if desired advisable.

Figure 139 shows the interior of an area being trephined and how protection of the dura is provided.

Figure 140 shows bone fragments in the trephined area; these may easily be removed with the special bone forceps (B).

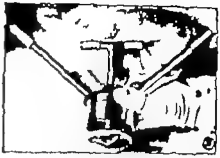


Fig. 141. Step 11. Unscrewing of the central system.

Step 12. (Fig. 141.) Unscrew the threaded axle with the key (A) until the trephined segment of bone and threaded axis get out of the crown. Replace the key in the head of the threaded axis. Introduce two pins of the lateral orifices of the cylindrical piece special hand-bar (10).

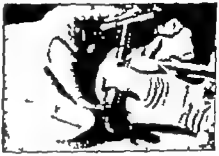


Fig. 142. Step 12. Removal of trephined section of skull.

Step 12. (Fig. 142.) This consists of the removal of the trephined portion of bone.

Step 13. (Fig. 143.) If desired, replace the trephined portion of bone. Consolidation takes place in about 8 or 10 days; the bone becomes united with the surrounding structures.

Step 14. (Fig. 144.) Unscrewing of the crown by means of the knobs (8c). Unscrew in the direction opposite to the arrows.

Figures 145-146 depict the technic of Combination procedure of Juntner trephining coupled with the Gigli saw.

Fig. 143. Step 13. Replacement of trephined segment.

As soon as the outer table of the skull is penetrated there will be less resistance felt to the advancing instrument and greater escape of blood coming from the diploe will be observed (Fig. 139.). After traversing the diploe, the hard bone of the inner table is encountered again; here greater caution must be exercised because the inner table is often very thin. For that reason, after

Fig. 144. Step 14. Unscrewing the crown.

every few movements of the trephine, the groove in the skull should be probed with blunt-pointed probe or the blunt point of a straight needle. Furthermore, the convexity and uneven surface of the skull may lead itself to greater penetration in one part of the groove than in another; pressure should, therefore, be adjusted at this point, remembering that the tables of the skull are not of

Fig. 145. Combination technic. Juntner trephine coupled with Gigli saw. Introduction of dura separator.

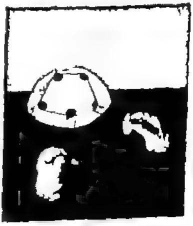


Fig. 146. Combination technic. Juntner trephine coupled with Gigli saw passing through the holes.

uniform thickness and that the inner table may be found cut through at one place before another. As soon as the bone is cut through, the button of bone is removed and the dura mater is exposed. The methods for arresting bleeding from the cut surface of the bone have been discussed above.

The usual size of a trephine is about three fourths of an inch in diameter; trephines more than one inch in diameter are generally impractical owing to the curving of the cranial vault.

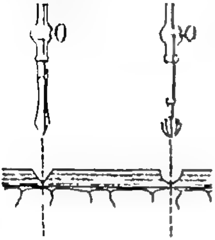


FIG. 1[illegible]. [illegible] showing the safe method of opening the skull. [illegible]

When trephining is done for decompression only, unless there are indications to the contrary, it is advantageous to open the skull under the temporal muscle where the bone is thin and [illegible]. Besides, the temporal muscle and fascia can be used to form an effective covering for the brain and prevent undue hernial protrusion ("subtemporal decompression"). In extensive decompressions for tumor, hernia cerebri often results (Fig. [illegible]).

Chisel and Mallet

This is followed by greater shock than when trephining is done as outlined. When, for one reason or another, this method is selected, proceed as follows: Have an assistant steady the head after preparing the skull as described above. After having exposed the skull by fashioning an appropriate flap, place a Doyen [illegible] chisel nearly parallel to the plane of the skull and by careful blows of

the mallet cause the chisel to cut a narrow groove in the bone. Deepen the groove gradually. Remove the desired segment of bone, thus exposing the dura mater.

FIG. 1[illegible]. Hernia following cranial decompression for tumor of the brain.

Gigli Wire Saw

This is a splendid instrument for the formation of a trephine opening in the skull (Fig. [illegible]). It enables the surgeon to remove a large area of skull in one piece. A U-shaped flap of appropriate size is fashioned. Reflect the pericranium. At each of the five points of the area to be removed, the skull is perforated with a small trephine or a Doyen perforator.

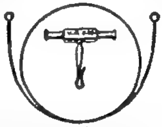


FIG. 1[illegible]. Gigli wire saw.

The latter is a very efficient and safe instrument conveniently operated by a brace. Before applying the perforator the outer table of the skull should be drilled so as to permit the conical perforator to bite. Separate the dura from the skull along the line stretching from one trephine opening to another by means of a dural separator. Introduce over an appropriately shaped grooved di-

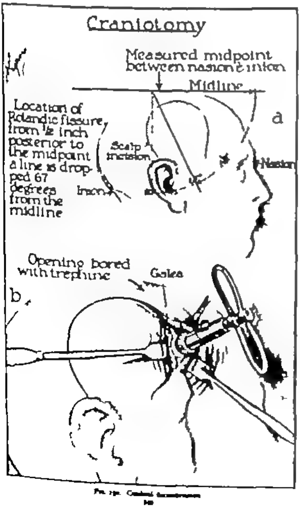


FIG. 1[illegible]. Cerebral decompression.

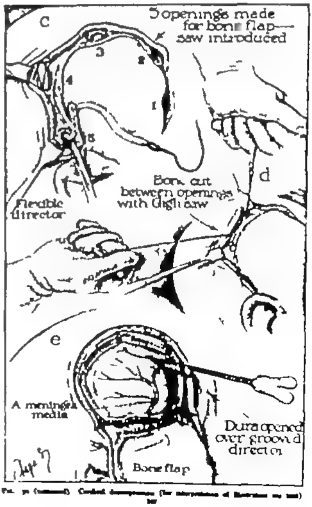


FIG. [illegible] (continued). Cerebral decompression (for interpretation of illustration see text).

rector to take the place of the dural separator. Pass Gigli wire saw along the grooved director; leave the director in place to protect the dura. The skull is now divided with the wire saw from within outwards either straight or beveled. Remove the director. This procedure is repeated until the desired area of bone is entirely detached. (Figs. 50 a, and b.)

Forceps

After perforating the skull as described, the bone may be divided between the perforations with bone-cutting forceps, Keen's or DeVilbiss' instruments (Fig. 151) being used instead of the Gigli wire saw. Krause's claw forceps are sometimes used to advantage in turning down an osteoplastic flap (Fig. 52).

Electric Saws, Etc.

Electrically driven circular saws and drills are used by some surgeons as means of rapidly opening the cranium. A good suction apparatus is of great aid in operative manipulations about the brain.

SUBTEMPORAL DECOMPRESSION

Cushing Modification

Step 1. Make a semilunar flap consisting of skin and fascia along the temporal crest. Begin the incision in front at a point little below and behind the lateral angular process of the frontal bone and terminate it posteriorly at the root of the zygoma. Dissect the skin and subcutaneous tissues downwards to the level of the zygomatic arch. Lay the temporal fascia bare.

Fig. 151. DeVilbiss cranial forceps.

Step 2. Divide the fascia in the direction of its fibers and continue to just below the temporal crest and to the level of the zygoma.

Step 3. Divide longitudinally and retract strongly the fibers of the temporal muscle in a line extending from the center of the temporal crest to the middle of the zygoma down to the periosteum; this is also divided longitudinally.

Step 4. With a periosteal elevator or rugine, separate the periosteum forwards and backwards until a considerable area of the bone forming the floor of the temporal fossa is exposed.

Step 5. Penetrate the skull with a Doyen burr (Fig. 53) and with a rongeur forceps remove bone under the separated soft parts as much of the skull as seems necessary; or with the aid of a trephine remove a circle of bone from the center of the exposed area as above described. Enlarge the aperture with bone forceps until a sufficiently large opening is created.

Step 6. If deemed necessary make an incision in the exposed dura under taking care to avoid large unengaged blood vessels and to ligate smaller ones which may be divided. (Figs. 54-155, 56.)

Step 7. Attend to hemostasis. Unite the fascia with fine chromicized catgut sutures. (Fig. 57.)

Step 8. Replace the skin flap and suture it in position with interrupted sutures.

Step 9. Pass a cigarette drain down to the dura and bring it out through small opening at the base of the flap. (Fig. 58.)

Fig. 152. Use of Krause claw forceps in turning down osteoplastic flap. (Krause-Thorek, Surgery of the Brain and Spinal Cord, F. J. Rebman Publishing Co.)

Cushing's Suboccipital Exposure by the Cross-bar Incision

Step 1. Make a curved incision a little above the superior curved line of the occiput. Add a longitudinal median incision running downwards from the middle of the curved incision. Reflect downwards and outwards the two triangular flaps of skin thus outlined until the upper portion or origin of the first superficial cervical muscles is exposed. Divide the muscles parallel to and about ½ inch from their line of origin. Make a median vertical incision between the muscles down to the spines of the upper cervical vertebrae and divide the ligamentum nuchae in the midline. Retract the soft parts. Expose the base of the occiput by separating the periosteum from it and with the periosteum separate the attachments of the deep muscles (Fig. 159.)

Step 2. Open the skull on each side through the prominent thin bosses of the occiput. *Enlarge the openings with rongeur forceps. The ridge of bone in the midline must be attacked with great care because of the occasional presence of the mid-occipital sinus and emissary veins.* Cushing finds it helpful to crowd wisps of sterile cotton ahead of the dural separator when freeing the membranes from this mid-ridge, a procedure which occasionally ruptures and blocks these emissary vessels in case they are present.

Step 3. When the bone defect is large enough, ligate the median occipital sinus and excise the dura corresponding to the opening in the bone.

Step 4. Close the wound, preferably without drainage. On account of oozing of blood a drain of folded rubber tissue or of oiled silk may be employed. Withdraw the drain within forty-eight hours.

Fig. 153. Doyen's burrs.

CLOSURE OF CRANIAL DEFECTS

Free, non-pedunculated transplantation of bone in cranial defects is much simpler to perform and is just as efficacious as the Müller-König method which requires dexterity and experience.

1. A portion of the tibia with its periosteum (von Eiselsberg' procedure) is transplanted.

2. Fragments of bone from the outer table of the skull taken at a distance from the defect may be used (Bruck's suggestion).

3. Replacement of the fragment removed by trephining.

4. Replacement of the scalp alone. Scar fibrous tissue appears, effectively protecting the brain from external trauma.

MÜLLER-KÖNIG METHOD

Step 1. Reflect a skin-periosteal flap exposing the cranial defect (Fig. 160a). Clear the defect of all scar tissue. Freshen the edges of the bone with fine chisel or rongeur.

Step 2. Outline another flap and reflect it as shown in Fig. 160. In shaping this flap include in it a portion of the outer table of the bone of the skull, cut away with the chisel, so that the portion of bone forms an integral part of this flap and corresponds in size and shape to the cranial defect into which it is to be fastened.

Step 3. The graft is now placed into the defect and the edges of the flaps are sutured in place as shown in Fig. 160.

It is difficult during the operative manipulations to avoid detachment of the portion of bone from the periosteum.

Comment. Bruck's Rules. 1. If the wound can be rendered and kept aseptic, close the defect at once by implantation of the fragments removed (Macewen's method).

Fig. [illegible] Cushing's [illegible] over the cerebellum.

If the wound is healed—do not wait for epilepsy to develop but excise the scar tissue from the cranial defect and repair it by the Muller-König osteoplastic method.

Macewen['s] method is applicable only when the bone removed is [illegible] able for reimplanting.

Autogenous Cranial Transplants

The technic employed is that used by Charles H. Frazier and requires practically the same preparation of the defect as is necessary [illegible] the transplant is taken from the tibia or [illegible].

Step [illegible] Make an incision around the boundaries of the old scar and remove the scar tissue (Figs. [illegible]).

Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible] Muller-König operation for closure of cranial defects. [illegible] of cranial defects by [illegible] flap. All scar tissue [illegible] the defect and the edges of the bone freshened.

Fig. [illegible] Formation of osteoplastic flap.

Fig. [illegible] Operation completed.

Step 2. Bevel the bony rim with [illegible] fine chisel and free the dura. Remove [illegible] bodies and bone spicules if accessible but do not deliberately open the dura (Fig. [illegible]).

Step 3. Make [illegible] pattern of the defect with rubber dam or muslin[;] place it on the pericranium of the parietal eminence of the same side or of the contralateral side when the defect is large (Fig. [illegible]). Outline the pattern on the bone with [illegible] small chisel and remove [illegible] thin lamina of bone with overlying pericranium (Fig. [illegible]). The transplant usually curls up during removal and resembles [illegible] thick fish-scale mosaic with the fragments held in contact by the pericranial covering. The graft is molded into the desired curve by pressure and placed upon the defect with its bony surface in contact with the dura. Fix the transplant in position by suturing the pericranium around the bony rim with that of the graft using fine interrupted catgut sutures (Figs. [illegible]).

Step 4. Close the wound in layers with fine rubber tissue drainage over the defect and the area from which the graft is taken. Keep the patient flat in bed about two weeks during which time the pressure of the [illegible] contents which the horizontal position favors will give the thin transplant the proper curve and permit it to set in [illegible] plane with the surrounding skull.

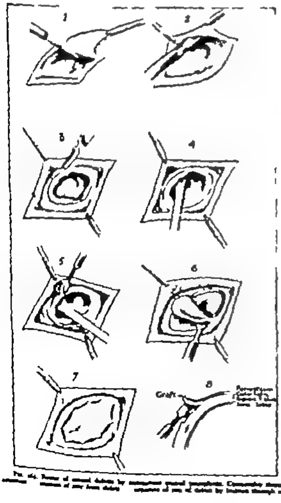


Fig. [illegible] Repair of cranial defects by autogenous cranial transplants. [illegible]

GENERAL PRINCIPLES UNDERLYING THE REMOVAL OF TUMORS OF THE BRAIN

The rudiments, at least, of cranio-cerebral localization should be thoroughly understood before [illegible] brain tumor is attacked. A competent neurologist should always check on the pre- and postoperative findings. If available, [illegible] neurosurgeons should be given preference. The occasional operator should proceed only where the aid of [illegible] specially trained colleague cannot be obtained.

The surgeon should acquaint himself with the normal and abnormal appearance of the cortex [illegible].

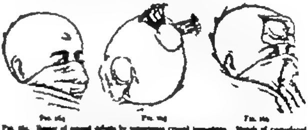


Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible] Repair of cranial defects by autogenous cranial transplants. Sketch of craniofacial defect. (Courtesy of Dr. C. C. Coleman.)

Fig. [illegible] The defect has been prepared for transplantation. The graft [illegible] outlined on the [illegible] parietal eminence.

Fig. [illegible] Complete suture of the graft. The incision in the scalp [illegible] usually closed with [illegible] double row of sutures.

Normally the dura and pia-arachnoid should not be incised except in the [illegible] of the [illegible] lesion. The vessels of the pia should be easily discernible. [illegible] along the large pial veins are of no moment.

[illegible] in the cortex is often difficult to detect[;] palpation may reveal difference in consistency.

Infiltrating gliomas or glioneuromas are of [illegible] color[,] slightly elevated and much more easily discerned.

Small reddish-brown areas resembling tumors are often observed on the cortex in cases of considerable bulging of brain tissue. These hemorrhagic spots often increase in size and, if incised, the brain tissue will be found soft and discolored[;] these are not to be looked upon as neoplasms.

[illegible]

EXPOSURE OF THE BRAIN

As a general example of procedure, a description of the main steps in the removal of a circumscribed tumor of the cortical aspect of the brain, by resection, through osteoplastic exposure follows.

Step 1. The skull may be opened by chisel and mallet, Gigli saw, rongeur forceps, electric saws, etc. Focal manifestations are the best guides to the portion of the brain sought.

Fig. 167. A, Osteoplastic flap, the site of ... ending of the right motor area; B, field of operation after removal of the tumor; C, tumor. (Redrawn from Thorek-Lewis: Surgery of the Brain and Spinal Cord, F. J. Bohman Publishing Co.)

If there are no guiding localization phenomena, an osteoplastic flap may have to be turned down in the suspected region, as an exploratory procedure, to be extended, if necessary, as subsequently indicated.

Comment. The contour, consistency and the presence or absence of pulsations of the dura will afford valuable information. In tumor or bleeding there usually is an absence of pulsations and the dura tends to bulge into the trephine opening. Palpation is of great aid in determining the presence of subcortical tumors. The experienced palpating finger has often correctly diagnosed subcortical tumors at a depth of one inch from the surface (Fig. 167).

Step 2. When the location of the tumor has been determined, the dura is incised

so as to form a flap with its pedicle oriented in the same direction as that of the osteoplastic flap. The flap of dura is raised at each end with Allis forceps and carefully turned downward, slowly elevating ... from the brain. Sometimes the tumor will tend to follow traction upon the dura; if ... curved scissors or blunt dissector is insinuated between the capsule of the tumor and the brain keeping its contour. Ligation of the blood vessels facilitates the enucleation of a circumscribed tumor. Double ligatures are placed around the vessels; they are tied; the long ends of the ligature serve as tractors; the vessels are severed between the ligatures (Fig. 168). If the dura is invaded by the tumor, the involved portion must also be removed.

Step 3. Blunt instruments or ordinary silver teaspoon aided by gentle dissection for the scooping out of an encapsulated tumor ... which enter in the ... at right angles to the brain surface. Hemorrhage is controlled

Fig. 168. Ligation of blood vessels around cortical tumor. (Redrawn from Kanavel-Thorek, Surgery of the Brain and Spinal Cord, F. J. Bohman Publishing Co.)

Controlled by ligation, clips, diathermy, compression with gauze or hot lap sponges.

Subcortical tumors should be reached by cutting through the summit of a convolution first; expose the tumor mass, gently retract the brain substance and remove the neoplasm with a spoon or scoop.

A small, curved soft metal tube, 3 to 5 mm. in diameter, connected with continuous suction apparatus, may be used to great advantage to clarify the view of deep-seated, vascular tumors showing slight macroscopic differences between normal and pathological tissue. Trauma to the brain substance is lessened by doing less sponging.

If the condition of the patient is unsatisfactory, finish the operation in one stage (see Step 5).

Step 4. If the patient shows a drop in blood pressure or an augmented pulse rate after the first part of the operation, suture the flap into place and postpone opening the dura for 5 to 10 days.

In two-stage operations, the dural flap is not sutured. It is simply laid back over the cortex. Part or all of the bone flap is removed.

Step 5. When the tumor ... detached from the brain substance but still adherent to an origin from the meninges (meningioma), it ... usually severed from

the brain by dividing the base of the dural flap to which it remains attached. The defect in the dura is usually repaired by some form of duraplastic procedure. A fascial flap from the aponeurosis of the fascia lata affords good repair material. The space in the fascia lata, after removing the flap, need not be repaired. While the cavity left in the brain after removal of a tumor sometimes requires drainage, it usually is promptly obliterated by the expansion of the brain.

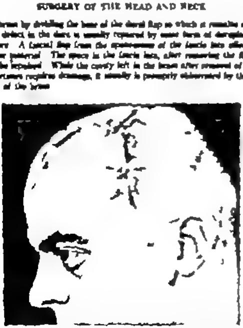


Fig. 169. Meningioma. Patient seven days after operation. Electrocoagulation of normal vessels near the site of the ... Adrenal compression ... no focal manifestations. Dura not opened but compressed in front of tumor and ... (From ...)

The dura is sutured back into place by either interrupted or continuous sutures. In cases with great tension, the dura cannot be sutured at all ... simply replaced over the brain.

Disposal of the bone flap ... governed by the degree of decompression desired ... part or all of ... may be removed or ... may be replaced in its entirety.

If ... trephine osteoplastic flap has been made, remove enough bone to permit of adequate drainage.

In tumors occurring on the left side in right-handed persons (and vice versa), and with decided increase in intracranial pressure, there is danger that cortical and subcortical laceration and hemorrhage with paralysis of arm, leg or speech may supervene following ... sudden protrusion. Harvey Cushing has recommended that in such cases a preliminary subtemporal decompression below and behind the Sylvian fissure be performed on the side opposite the tumor.

TUMORS OF THE CONVEXITY OF THE HEMISPHERES

Unless unusually large, neoplasms occurring on the outer surface of the dura mater are usually easily removable. They are completely enveloped and are easily detached from the cortex. The incision should begin in one side of the tumor. Occasionally a portion of the dura has to be sacrificed. After the attachments of the tumor are severed, it is gently removed from the cortex. Small vessels are ligated with fine silk or catgut, clips or electrosurgical hemostasis may also be employed. Hemostasis ... often effected by small cotton pledgets. The depression left by the removal of the tumor usually fills promptly. The edges

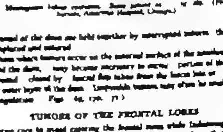


Fig. 170. Meningioma before operation. Same patient as ... Fig. 169. (From Author ... American Hospital, Chicago.)

of the wound of the dura are held together by interrupted sutures; the bone flap then replaced and sutured.

In cases where tumors occur on the external surface of the meninges or have perforated the dura, ... may become necessary to excise a portion of the dura. If so the wound ... closed by a fascial flap taken from the fascia lata or ... flap taken from the outer layer of the dura. Inoperable tumors may often be ameliorated by electrocoagulation (Figs. 69, 170, 171).

TUMORS OF THE FRONTAL LOBES

Exercise care to avoid entering the frontal sinus while fashioning the bone flap over the frontal lobes. The flap should be large enough so that all parts of the frontal lobe may be thoroughly examined. Exposure of a subcortical tumor may be accomplished solely by incising the right or left frontal lobe well toward the front avoiding injury to the long motor association tracts. In infiltrating tumors replace the dura and osteoplastic flap because hernia is apt to follow. In removing a tumor from the lower surface of the frontal lobe, avoid injuring the olfactory bulb.

TUMORS OF THE TEMPORAL, PARIETAL AND OCCIPITAL REGIONS

In operating on the cortex over the Rolandic area present [illegible] partly or permanent paralysis of one or more extremities may ensue. If the operation is low down on the left side (right-handed) or left-handed persons on the right, the patient may lose his power of speech.

Tumors occurring in the lower part of the temporal lobe [illegible] may require an

Fig. [illegible] Extensive [illegible] after operation. [illegible] (Photograph of [illegible] [illegible] Author [illegible] Hospital [illegible])

incision [illegible] of bone down to the base of the skull [illegible] only [illegible] so doing can efficient access to the under surface of the temporal lobe be obtained.

If the ventricle has been opened in removing [illegible] tumor make no effort to close it. A piece of Cargile membrane may be used to cover the opening.

SUBTENTORIAL TUMORS

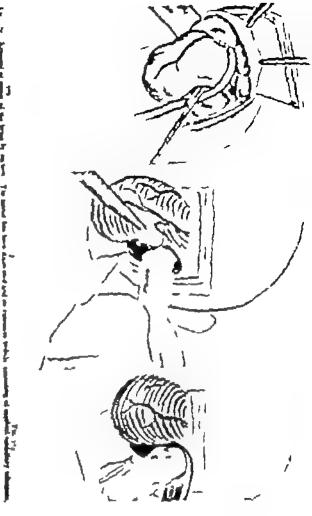
(Figs. [illegible])

Excision of a tumor from the cerebellar hemisphere or the cerebellopontine angle is more difficult than operating in the cerebral hemispheres. Operations here are usually performed in two stages.

Stage I

Step [illegible] Incise the dura. Palpate the hemisphere and if necessary explore [illegible] an aspirating needle.

Step [illegible] When the tumor [illegible] subcortical, ligate the large pial vessels and make transverse incision [illegible] to hemostasis. This is usually not difficult. In infiltrating tumors a large portion of the hemisphere may have to be sacrificed.



Tumors at the cerebellopontine angle tax the skill of the surgeon. Tumors here are usually of long duration and are closely connected with the nerves and brain. They frequently spring from the auditory nerve and resemble [illegible] neurofibroma.

Stage II

Step [illegible] Expose the tumor by retracting the cerebellar hemisphere toward the midline, forcing the [illegible] cerebellum toward the opposite side. Use [illegible] brain depressor bent to the proper angle.

Step [illegible] Retract the cerebellum toward the opposite side thus exposing the posterior surface of the petrous portion of the temporal bone. With [illegible] suction apparatus or by intermittent sponging, clear the fluid coming from the lateral subarachnoid cistern which has been punctured.

Step 3. Free the tumor from its actual attachments, gently working away from the pons and medulla. If the tumor [illegible] large [illegible] may become necessary to divide the auditory nerve [illegible] avoid injury to the facial nerve.

The manipulation of tumors of considerable size may cause interference with respiration. If the cerebellum [illegible] [illegible] third operation may be necessary. Protect the cerebellar tissue from injury.

Step 4. After removal of the tumor attend to hemostasis. Permit the hemisphere to return to its base. The wound [illegible] closed in the usual manner. The muscles of the suboccipital region sufficiently protect the cerebellum so that suture of the dura [illegible] not imperative.

ANGIOMAS (PIAL) OF THE CEREBRAL HEMISPHERES

Choose good exposure, select a large branch of the principal vessel, doubly ligate [illegible] the sulci and divide [illegible] between the ligatures. Hemorrhage [illegible] likely here (the vessel walls are easily torn). Work very cautiously. Electrosurgical methods serve here well.

CYSTS AND CYSTIC COLLECTIONS OF FLUID IN THE BRAIN

For an exhaustive description of this condition the reader [illegible] referred to the author's English adaptation of Krause: Surgery of the Brain and Spinal Cord.[1]

Meningitis serosa circumscripta (Oppenheim and Krause) [illegible] not frequent and occurs only in the posterior cranial fossa. Brain cysts arise either from an old hemorrhage or from [illegible] soft gliomas. For method of thorough exposure see Fig. [illegible], p. [illegible].

In facing this problem, make sure [illegible] before operating the brain tissue that the distended lateral ventricle is not inadvertently aspirated. Fluid from a cyst is usually of [illegible] yellowish or greenish color, normal cerebrospinal fluid [illegible] quite clear. It [illegible] well to remember that an old hemorrhage into the ventricle or tumor near the lateral ventricle may cause the ventricular fluid to present a yellow or greenish hue.

Step [illegible] Incise the brain tissue and expose the cyst cavity.

Step 2. If the cyst wall is thick, excise [illegible]. If this is impossible, endeavor to destroy [illegible] by electrosurgical means. (Electrocoagulation.)

The prognosis of simple cysts [illegible] favorable although it [illegible] at times difficult to differentiate between these and gliomatous cysts.

[1] Rebman Publishing Co., 1909.

Frazier [illegible] Transfrontotemporal Intracranial Method for Removal of Tumor of the Hypophysis Cerebri

This operation [illegible] performed where x-ray plates reveal [illegible] tumor and the diagnosis is based on clinical manifestations produced by the neoplasm. In such cases, the tumor overgrows the sella turcica and involves contiguous areas of the frontal and temporal lobes, causing symptoms. The operation is performed in two stages. (Figs. [illegible])

Stage I

Step [illegible] Make an osteoplastic flap over the temporoparietal region. This should hinge backward and its dimensions should approximately be 3½ inches

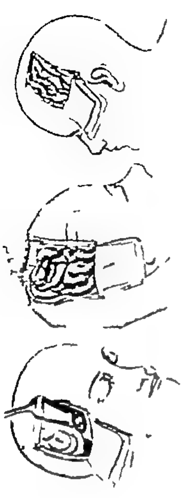
[illegible] Tumor of the pituitary gland. [illegible] of sella turcica and clinoid processes [illegible].

anteriorly 3½ inches posteriorly 3½ inches above and 3½ inches below. Wait about [illegible] week.

Stage II

Step [illegible] About [illegible] week later raise the osteoplastic flap again and turn it back. Fashion [illegible] dural flap which hinges downward. Ligate the presenting branches of the middle meningeal artery.

Step 3. With [illegible] spatula lift up the frontal lobe, from the frontal fossa, the anterior fossa of the skull, the posterior border of the lesser wing sphenoid, the [illegible] running over it, the anterior clinoid process and the temporal lobe of the brain posterior to the lesser wing of the



[illegible]

With smooth forceps, push the olfactory nerve backward, so doing remove the obstruction on the way to the hypophysis. After the frontal lobe of the brain is moved farther away from the bone, exposure of the hypophyseal tumor and the operative field is accomplished.

FIG. [illegible] Exposure of the optic [illegible] for hypophyseal tumor. [illegible] (Redrawn from Kramer-Thorek, Surgery of the Brain and Spinal Cord, F. J. Rebman Publishing Co.)

Step 4. Further displacement of the brain from the tumor is brought about by means of gauze held in curved forceps. The tumor may be removed by suction, finger or spoon.

Effective lifting up of the frontal brain brings to view the sella turcica, dorsum sellae, the anterior clinoid process, the [illegible] of the roof of the corresponding orbit, the crista galli and both sides of the ethmoid bone. The usual measures are used to check hemorrhage.

Step 5. After the tumor is removed, replace and suture the dural and osteoplastic flaps. Drainage is usually unnecessary.

EPILEPSY

Focal or Jacksonian

In Jacksonian epilepsy the irritation seems to originate in some particular point on the surface of the brain and to radiate to other parts. An endeavor should be made to ascertain the parts affected by cerebral localization (Figs. 177-178-179).

The causes for epileptic seizures are usually (a) depressed fracture, (b) osteophytic growths, (c) tumors, (d) localized meningeal adhesions, (e) hemorrhage, abscess, cysts, etc.

If no macroscopic lesion is found when the skull is opened and the brain exposed, the precise area from which the attacks radiate may be defined by means of stimulation by weak electrical currents. When a definite area is located, excise the gray matter of the affected part together with the pia-mater covering it. Excision of an area of cortex causes prompt paralysis of the regions controlled by that area, but such paralysis seldom remains permanent. One may argue that a scar removed from the brain will be supplanted by another scar. True, nevertheless, there is a vast difference between a scar resulting from violent trauma or inflammation and that occasioned by a clean, aseptic scalpel incision.

FIG. [illegible] Exposure of the [illegible] portion of the temporal bone. (Redrawn from Kramer-Thorek, Surgery of the Brain and Spinal Cord, F. J. Rebman Publishing Co.)

Step 1. Form a flap embracing the scar of the original trauma. Dissect the adherent scalp freely from the underlying bone. Inspect the bone thoroughly. Where, in severe injuries, the scalp is adherent to the dura or bone, direct the edge of the knife toward the outer portion of the flap.

Step 2. Examine for fracture. If none is found trephine over the area suspected, because there may be a depressed internal table, subdural hematoma, arachnoid cyst, etc.

Step 3. When a fracture is located, remove the bone directly concerned in the traumatized area. This applies to both fissured and depressed fractures. (For methods of procedure see under fractured skull.) Avoid injuring the dura which is frequently adherent to the inner aspect of the bone. Use DeVilbiss forceps to bite out the area involved. Where dura, bone, bone-defect and scalp are united in one mass, dissect these out thoroughly and painstakingly. Dissect the dura free from the superimposed structures.

Step 4. Where the dura pulsates and has not been injured during the opera-

tive manipulations and presents a normal appearance, stop and close the defect in the skull.

Where the dura bulges and there apparently is intracranial pressure, incise the dura crucially. Look for [illegible] underneath it (hematoma, cysts, etc.). A hematoma should be washed out, a cyst should be shelled out in its entirety or if that is not possible, partial excision with drainage may be resorted to.

Where the dura is adherent to the brain, dissect it away carefully sparing the brain pia-arachnoid region. Complete the dissection by leaving, as nearly as possible, healthy cerebral tissue.

The cortical scar should be removed (superficial portion).

Step 5. Attend to hemostasis. Prevention of adhesions between the dura and the brain may be accomplished by interposing silver foil, rubber or a fat implant.

Step 6. Replace the skull-flap and suture it in place.

Idiopathic Epilepsy

The term "idiopathic epilepsy" is used as a cloak for ignorance and is contradistinction to the focal forms of the disease. The results of a decompression procedure in this domain of surgical endeavor have been good, bad and indifferent.

In many of these cases, scars will commonly be found after careful inspection of the shaved scalp even when no history of trauma has been elicited. Many of these scars are undoubtedly the result of accidents other than that causing the epileptic seizures.

W. W. Keen was so firmly convinced that a scar of the scalp may be the cause of epilepsy that after having excised the scar and having found the bone without evidence of injury he closed the wound and waited. If after excision the patient failed to recover, Keen then—and not until then—considered the advisability of performing some other operation.

In traumatic epilepsy Friedrich chose the site of trauma as the site for operation even when the "aura" would indicate some other location as the starting point of the epileptic explosion.

Theodore Kocher believing increased intracranial pressure to be the important etiologic factor in so-called "idiopathic epilepsy," trephined the skull, at general preparation, and excised the dura mater over the right frontoparietal region. This he occasionally supplemented by drainage of the lateral ventricle.

In the absence of evidences of old trauma, Friedrich followed Kocher and operated over the posterior portion of the frontal lobe. He reflected a large flap of scalp, having its pedicle below. The skull was then opened and a segment of bone, from 20 to 48 sq. cm. (3 to 19 sq. in.), excised with forceps or other instruments. An area of dura varying in size from 9 to 13 sq. cm. (1½ to 2 sq. in.) was then carefully removed taking care not to injure the subjacent pia and avoiding as far as possible all hemorrhage.

The flap was then replaced and the scalp sutured.

Causes of Failure After Trephining for Traumatic Epilepsy

(a) Undetected bone fragments.
(b) Excessive thickening of the bone around the site of the injury.

(c) The [illegible] are [illegible] thickened and [illegible] to permit their [illegible] detachment.
(d) Permanent changes in the [illegible] by reason of the long period that has elapsed from the time of injury.
(e) [illegible] conditions.
(f) Trephining [illegible] defects [illegible]
(g) Postoperative complications (meningitis, cerebral abscess, etc.)

DIAGNOSTIC PUNCTURE OF THE BRAIN VENTRICLES AND CISTERNAE

VENTRICULAR PUNCTURE

[illegible] is required for ventricular puncture [illegible] to the [illegible] highly [illegible] and [illegible]

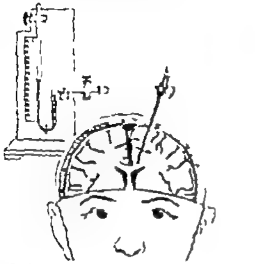


Fig. [illegible] Ventricular puncture, measuring intraventricular pressure.

Step 1. Place the patient on the operating table in such a manner that the head [illegible] the surgeon stands behind.
Step 2. Prepare the skull as for an operation on the brain in general (see above [illegible] that no [illegible] should be used). Local infiltration anesthesia is of distinct advantage at the point of puncture.
Step 3. Make a small incision down to the bone which is exposed. Perforate

the bone [illegible] placed at an acute angle [illegible] the surface of the skull. The work is done more rapidly [illegible] comfort to the patient and is not so [illegible] hand drawn [illegible] used.

Step 4. When the dura is reached, the needle [illegible] is introduced at an acute angle. Sometimes difficulties are encountered in finding the opening made by the bur on account of the displacement of the scalp structures. [illegible] of bone and bone dust resulting from perforating the skull must be meticulously [illegible] away [illegible] but the needle does not [illegible] of these into the brain substance. The needle should be blunt pointed. The needle [illegible] not be less than [illegible] to permit thick pus to escape should such be encountered. Another advantage of larger [illegible] needles

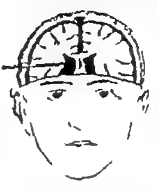


Fig. [illegible]

Fig. [illegible]

Fig. [illegible] Method of performing ventricular puncture by the lateral route.
Fig. [illegible] Method of performing ventricular puncture by the superior route.

is that they are not so likely to injure cerebral vessels, in transit, as are finer needles.

Step 5. After the ventricle has been entered ascertain the cerebral pressure with [illegible] manometer which is attached to the needle left in situ (Figs. [illegible]). In order to obtain microscopic particles of tumor from the brain substance the needle is introduced in the suspected tumor bearing area and these are removed by suction into an aspirating syringe. These microscopic particles have been used by the German school for diagnostic purposes.

In this country the majority of neurosurgeons have abandoned this method, preferring in cases where diagnosis of tumor is sought, not to resort to blind puncture but to explore the involved area by exposing the suspected region and investigate it at close range and with less hazard than that incident to brain puncture. To explore a certain area of the brain (ventricles, certain regions of the hemispheres) thorough understanding of craniocerebral topography is essential (see pp. [illegible], Figs. [illegible]).

Suction must be carefully avoided in ventricular puncture. The pressure in the ventricle will do all the work that is needed. Suction produces negative pressure in the ventricles and leads to undesirable results.

Step 6. When through, withdraw the needle. Close the puncture wound with [illegible] Done.

Kausch also punctured the fourth ventricle. In the two cases in which this was done, the cerebellar hemispheres were exposed, together with the occipital bone, after which the exploring needle was introduced at a point where the dura meets the junction of the medulla oblongata and the cerebellum. The needle was introduced carefully and directed forward and upwards at an angle of [illegible] degrees in relation to the horizontal. The progress of the needle was slow until cerebrospinal fluid issued. As soon as that obtains, one must, of course, stop at once to avoid injury to the important nerves at the floor of the fourth ventricle.

VENTRICULOGRAPHY

Dandy[1] has substituted air for the fluid taken from the ventricles by ventricular puncture. He terms the procedure ventriculography which by means of x-ray enables one to study the outlines of the ventricles. By ventriculography one may ascertain the degree of compression of particular ventricles by existing neoplasms. In expert hands the method is free from danger.

Ventriculography via the Anterior Horns[2]

The patient is placed on the operating table in the cerebellar position. The head is extended sufficiently for access to the frontal lobe. Local anesthesia is preferable.

Step 1. The head of the operating table is raised to suit the convenience of the surgeon.
Step 2. The scalp incisions are made in the hair line, being placed about [illegible] inches to either side of the mid-line. Trephine openings are made about ½ inch anterior to the coronal suture line after which the ventricle-needles are introduced at a slight angle to the perpendicular plane of the frontal bone. The points of the needles are directed slightly toward the position of the inferior temporal plane.
Step 3. After the needles have entered the cavities of the anterior horns the stylets are withdrawn.
Step 4. Measure the ventricular pressure with a manometer. Accurately measure the collection of the fluid obtained. Lower the head of the operating table so that the patient's head is lower than the body, thus completing ventricular drainage.
Step 5. Inject air through one needle until it escapes from the opposite one.
Step 6. Withdraw the needle into which the air has been injected and inject [illegible] of air into the remaining needle until slowly withdrawn.
Step 7. Elevate the head of the operating table. Close the wounds. Turn over the patient to the radiologist for further study.

[1] Annals of Surgery, [illegible]
[2] The [illegible] Medical Journal, Vol. [illegible], No. [illegible], Dec. [illegible]

Comment. Frazier contends that puncturing the anterior horns through the frontal lobe is anatomically and physiologically well grounded. He points out that some upsetting results using the posterior route have been noted.

Dangers of Cerebral Puncture

1. Injury to vessels. With care, these may be readily avoided. Occasionally by reason of anatomical abnormalities or vascular tumors, death may ensue from injuring a vessel. Pfeifer reports a death from perforating the artery of the corpus callosum, while Kartner perforated the transverse sinus without ill results and at another time he drilled through the canal of the middle meningeal artery without injuring it. On the other hand, Auvray reported two fatalities following injury to the transverse sinus.
2. Entering the needle too deeply: only experience and careful work with the use of proper instruments will tend to avoid such casualties.
3. Infection.
4. Pushing the exploring needle through the tumor into healthy territory thus causing implantation metastases.

Tilmann reported a case of death of a patient in whom the medulla oblongata was punctured during the exploration. This happened in a case of tumor of the acoustic nerve about the size of a hen's egg which displaced the medulla. Four hours of artificial respiration did not save the patient.

Comment. In doing ventricular puncture (a) be prepared to treat complications that may ensue. (b) In increased intracranial pressure, ventricular puncture is preferred by many to lumbar puncture. (c) In posttraumatic cerebral edema, ventricular puncture is often of considerable value. Dandy points out that in many instances a bone flap may be saved or a decompression avoided which might otherwise be necessary. Punctures of the ventricles are considered of such value in some cases that one, two or more are often made either in the anterior or posterior horns of the lateral ventricles. They are quite harmless if performed by a skilled surgeon, but may be dangerous in the hands of an operator who is not thoroughly versed in the topography of the ventricular system. Dandy's aphorism that a ventricular puncture improperly performed is much less safe than a lumbar puncture should be given unreserved heed.

Cisternal Puncture

The same precautions are here observed as in lumbar puncture. While the puncture is made, avoid injury to the tumor or cerebellum: edema and hemorrhage may result if precautions are not taken. In tumors in the posterior fossa of the skull, the cisternae magna is obliterated.

In brain tumor cisternal puncture is contraindicated. Lumbar puncture is much safer and should be preferred. Cisternal puncture is less painful and followed by less severe headache than is lumbar puncture, particularly when performed with the patient sitting instead of lying down.

Technic. Insert the needle just above the foramen magnum to the line of the occipital bone; do not insert the needle too deeply.

HYDROCEPHALUS

According to Dandy there are three general types of obstruction producing hydrocephalus (a) congenital malformations (b) tumors and other space-occupying lesions (c) inflammatory sequelae

Congenital malformations are occasioned by atresia of the aqueduct of Sylvius failure of the foramina of Luschka and Magendie to develop; failure of the subarachnoid space—either the cisternae or the branches which pass to the surface of the cerebral hemispheres—to become patent.

Tumors of any type and in many locations may occlude part or all of the ventricular system or the subarachnoid space

Inflammatory obstructions are most frequently located in the cisternae and at the foramina of Luschka and Magendie but the foramen of Monro and aqueduct of Sylvius may be affected. At times the outermost of an infective process surrounding an abscess may occlude the cisterna, the aqueduct of Sylvius, the lateral foramina, foramen of Monro, or even the ventricle itself

Attempts to drain cerebrospinal fluid into other cavities—the scalp the subdural space the cisterna magna, the peritoneal and pleural cavities, the retroperitoneal tissues—are impractical for one or both of two reasons, i.e. the fistulous tract, whether it be a simple channel in the tissue a tube of transplanted tissue (veins or fascia) or one of the foreign material (rubber tubes or drains) soon closes and the fluid soon becomes walled off, owing to the reaction of the tissues.

"The German 'Balkenstich,' or puncture of the roof of the third ventricle is a failure because the connective tissue (arachnoid) rapidly soon closes the opening and even if the opening could have persisted, absorption of the fluid is impossible because it passes into the non-absorbing subdural space the fluid cannot, by any conceivable closure reach the subarachnoid space

In children and adults have tumors form the overwhelming percentage of obstructions, the hydrocephalus is automatically cured by removal of the tumor

"The obstructions prevalent in infancy—strictures of the aqueduct of Sylvius, occlusions at the foramina of Luschka and Magendie and closures of the cisternae—offer entirely different problems in treatment.

The fluid can be absorbed only in the subarachnoid space and there is only one part of the subarachnoid space which is large enough to make it mechanically possible for fluid to enter from the ventricular system, namely the cisternae elsewhere the subarachnoid spaces are too closely applied to the brain. Moreover there is only one very restricted part of the ventricular system which is in close apposition with the cisternae—the floor of the third ventricle And finally the floor of the third ventricle appears to be the only part of the ventricular walls that is sufficiently thin and devoid of neuraglia to offer a chance of a permanent fistula.

Dandy's Operation for Obstructions at the Aqueduct of Sylvius or the Foramina of Luschka and Magendie—Third Ventriculostomy (Floor of Ventricle)

Commenting on the methods of surgical treatment of hydrocephalus in vogue Dandy says that repeated ventricular punctures which have been practiced since the time of Hippocrates, and lumbar punctures, are useless because the fluid quickly reforms while a permanent, external fistula quickly leads to meningitis and death

The original approach proposed by Dandy was under the frontal lobe where it became necessary to divide one optic nerve to gain access to the floor of the third ventricle in the region of the cisterna interpeduncularis. The lateral approach has supplanted the frontal, which has greatly simplified the procedure. The optic nerve is no longer sacrificed, no scar is visible, the floor of the third ventricle is reached much more directly and at the cisterna interpeduncularis, the stalk of the hypophysis can be seen and avoided, and most important of all, Dandy believes that the formation of an external hydrocephalus will be far less probable because a projecting shelf of dura separates the cisterna from the temporal lobe and acts as a barrier to the flow of fluid into the subdural space. (Fig. 184)

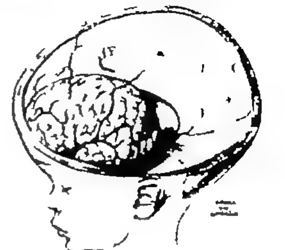


Fig. 184. Drawing of brain showing external hydrocephalus. The fluid is in the subdural space and not in the subarachnoid space. (Dandy in Lewis' Practice of Surgery W. F. Prior Company, Inc.)

Step 1. A plaster cast is molded to the infant's head. A defect is made in the cast overlying the temporal region of the side to be operated upon. (Fig. 185)

Step 2. A small curved incision is made in the temporal region (either side), beginning in front of the tragus of the ear and extending upwards and forwards. (Fig. 186)

Step 3. The temporal muscle is incised

Step 4. A small area of bone is removed about the base of the skull.

Fig. 185. Plaster cast covering head. The [illegible] used to fix the skull so that the head cannot collapse when the ventricular pressure is released. [illegible] the skull, the [illegible] would collapse and [illegible] would not be possible [illegible] in which to work. Moreover [illegible] of the head would produce injury to the large [illegible] venous sinuses and to the brain stem. (Dandy in Lewis' Practice of Surgery W. F. Prior Company, Inc.)

Step 5. The flap of dura is reflected toward the base

Step 6. The head is then lowered about 30°

Step 7. The descending horn of the lateral ventricle is tapped and 60 to 80 cc. of fluid evacuated. A short flanged ventricular needle is left in place during the operation

Step 8. The temporal lobe is depressed with a spatula until the lateral wall of the cisterna interpeduncularis comes into view

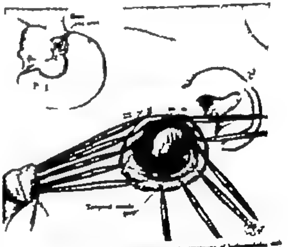


Fig. 186. Operative approach for third ventriculostomy in the treatment of hydrocephalus with ventricular obstruction. (Dandy in Lewis' Practice of Surgery W. F. Prior Company, Inc.)

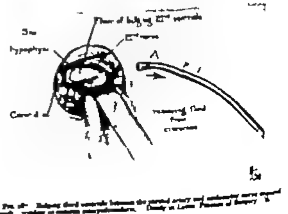


Fig. 187. Bulging third ventricle between the carotid artery and [illegible] nerve exposed through [illegible] cisterna interpeduncularis. (Dandy in Lewis' Practice of Surgery W. F. Prior Company, Inc.)

Step 9. The choroid wall is opened behind the oculomotor nerve, between the carotid artery and the oculomotor nerve. Both of these structures stand out in the foreground and must be protected from injury from undue traction (Fig. ...).

Step 10. After the field ... the lamina ... the floor of the third ventricle is opened as widely as desired (Fig. ...). The opening is ... just posterior to the hypothalamic ...

Step 11. The space remaining is filled with salt solution. The dura ... the scalp is closed in layers with interrupted sutures of silk.

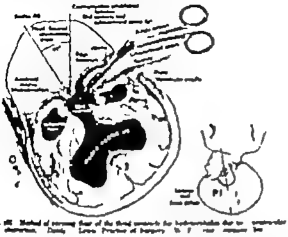


Fig. 166. Method of opening floor of the third ventricle for hydrocephalus due to ... ventricular obstruction. (Dandy: Lewis' Practice of Surgery, W. F. Prior Company, Inc.)

Hydrocephalus due to ... choroid block does not appear to offer any prospect of ... the ventricular fluid since the cisternae are obliterated.

Dandy suggested removal of the choroid plexus from both lateral ventricles for this type of hydrocephalus, as yet the survival period has not been long enough to be certain of cures. The reasons upon which the operation is based are:

(a) There is absorption from the spinal subarachnoid space (normally about one-fourth to one-fifth of the amount from the entire subarachnoid space) if we may accept the absorption tests with phenolsulphonphthalein.

(b) The choroid plexus of both lateral ventricles represent perhaps two-thirds or three-fourths of all the fluid forming organs.

It, therefore, seemed possible that after the removal of the entire choroid plexus from both lateral ventricles, the quantity of fluid formed would be so far reduced that the absorption from the spinal canal would be adequate. In ... patients from whom the choroid plexus had been removed, a hydrocephalus

of this type had ... It is ... to ... with ventricular obstruction ... by the slow extension of the ... in the ... at the base of the ... At ... the ... of the ... of ... in the ventricle ... that one suspects ... ventricular block and subsequently complete ... Where the ventricular openings are widely patent the ventricular ... is ... be ...

W. E. Dandy: Extirpation of the choroid plexus. Ann. Surg. ...

CHAPTER 9

SURGERY OF THE EARS AND ADJACENT STRUCTURES

OPERATIONS ON THE EXTERNAL EAR

HEMATOMA AURIS

This is usually caused by trauma to the auricle ... dark swelling occurs on the anterior surface of the auricle often associated with severe pain. Treatment consists of aspirating the blood under strict asepsis and applying firm pressure. In extensive cases, an incision must be made and the clot removed with ... curet and pressure applied.

CAULIFLOWER EAR

If ... hematoma auris is untreated, scar tissue is formed, the contracture of which gives rise to the cauliflower ear.

Dan H. Palmer reported the following operation as being satisfactory:

Step 1. Sterilize the outer ear and contiguous region with any good antiseptic except iodine. Introduce cotton in the outer auditory canal.

Step ... Incise the swelling on the ear at its most projecting portion and remove with ... curet or fine gouge all newly formed cartilage or bone as well as blood clots. Continue the curving until the surface ... smooth.

Step 3. Bring the edges of the wound together leaving ... small aperture which will allow the insertion of ... Eustachian catheter attached to ... Pynchon pump which serves to extract the blood which has collected and assists in the approximation of the skin, cartilage and perichondrium.

Step 4. After drying the skin, plug the auditory canal with ... fresh dry piece of non-absorbent cotton. Boric vaseline is applied over the ear and surrounding regions.

Place ... cardboard mold around the ear then

Step 5. Encase the entire ear in plaster of Paris through which the Eustachian catheter is permitted to emerge ... that is attached to the pump. The catheter is incorporated in the plaster ... so that it may be removed easily when the plaster is completely hardened and the space ... occupied is used as ... drain. The plaster is held in place with gauze and removed in pieces after ten days.

PROMINENT EARS

Step ... Remove the skin and fascia between the points 1, 2, 3 and ... as outlined in the illustration (Fig. 169). A semi-ellipse will result on the skull-surface and one on the back of the ear. The skin removed from the auricular surface must be greater than that taken away from the mastoid region.

Step 2. Unite the cutaneous margins with interrupted silk sutures.

Kolle advises the removal of an ellipse of cartilage. This is usually necessary ...

because if some auricular cartilage is not taken away the tendency of the cartilage will probably render the operation inefficient and recurrence will result.

Goldstein ... operation consists of excising an elliptical portion of the cartilage of ... ear depending upon the amount of projection present and suturing the margin of the cartilage to the periosteum at that point.

Fig. 169. Protruding ears.

MACROTIA (EXCESSIVELY LARGE EARS)

GASKELL ... OPERATION

Step 1. Make an incision embracing ... the structures of the auricle corresponding to the line and curve of the antihelix.

Step 2. Beginning at each extremity of this incision, make ... curvilinear incisions towards the outer margins. (Fig. 170.)

Step 3. Excise ... small, tongue-shaped flap extending towards the external border of the ear from the incision last described. This will shorten the long diameter of the ear while the crescentic incision will reduce the width of the excision.

Step 4. Suture the defect.

REMOVAL OF FOREIGN BODIES FROM THE AUDITORY CANAL

The method used for removing ... foreign body from the auditory canal is, of course, determined by the size, shape and degree of impaction of the object.

Small objects which are not impacted may be removed by simply irrigating the ear. An article like ... button may be removed by hooking ... tenaculum in its eye; objects which can be crushed (peas or beans) may be extracted by an angular tenaculum inserted in the compressed substance and withdrawn ... should be removed immediately to avoid their injuring the tympanum

gation is often sufficient for their removal; however they may be killed by pouring melted vaseline in the ear followed by a piece of cotton soaked in chloroform.

Hard, round objects which almost completely fill the canal furnish the greatest difficulties. Care should be taken that they are not pushed in further during manipulations.

Step 1. Illuminate the auditory canal with a strong headlight.
Step 2. Insert delicate forceps; grasp the foreign object and withdraw it.

If this does not seem feasible, an instrument resembling a blunt, curved crochet-needle is inserted in the canal beyond the object while hugging the wall

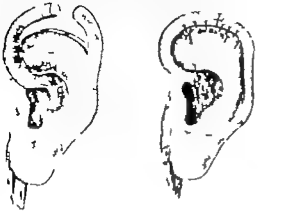


Fig. 190. Forked operation for removal.

of the auditory canal, then the hook is applied to the middle of the object and withdrawn.

A straight instrument inserted in the same manner sometimes suffices.

FURUNCLE OF THE AUDITORY CANAL

Furuncles are usually found on the cartilaginous canal walls or on the inside of the tragus. If abortive measures are unsuccessful the furuncle should be opened, followed by sterilization with tincture of iodine which is washed off with alcohol. For analgesic purposes, pure carbolic acid is applied to the point of the furuncle or a mixture of cocaine, carbolic acid, menthol and alcohol. Nitrous oxide is of value in certain cases.

Introduce a lubricated ear speculum opposite the location of the furuncle. With a proper scalpel thoroughly incise the furuncle. Curet its bed. Swab it with carbolic acid followed by alcohol. Pack with gauze and drain.

REMOVAL OF POLYPI FROM THE AUDITORY CANAL

Polypi are usually found in the tympanic cavity on the membrane and the walls of the auditory canal and are always associated with suburate suppuration or chronic otorrhea.

Step 1. Irrigate the ear.
Step 2. Insert a speculum and adjust the snare over the pedicle of the polypus.
Step 3. Draw down the wire steadily and carefully so that the pedicle is detached without any rough manipulations causing damage to the middle ear.
Step 4. Irrigate the canal from which the polyps have been removed and insert a gauze dressing, following which the chronic otitis media must be treated.

Comment. Polypi are often attached to important structures of the middle and internal ear. Even with the greatest care, serious accidents may occur in their removal such as facial paralysis and labyrinthitis. A safer method of removing them is frequent cauterization with strong solutions of silver nitrate.

REMOVAL OF EXOSTOSES OF THE AUDITORY CANAL

The purpose of this operation is to restore the lumen of the auditory canal. Unless exostoses give rise to symptoms (they usually do not) they are best left alone as their removal is often beset with numerous operative difficulties. Smaller growths may be removed through the canal while larger ones may require a post-aural incision. The smaller exostoses made up of compact bone are most satisfactorily removed with a long, slender bone-gouge.

Step 1. If the canal is considered of sufficient size to perform the operation satisfactorily irrigate the ear with an antiseptic fluid.
Step 2. Insert a speculum into the auditory canal.
Step 3. With a tenotome, or a curved bistoury make an incision over the tumor in such a way that a small flap is fashioned and placed against the side of the canal.
Step 4. Insert a fine chisel into the canal either while the speculum is in place or after it is withdrawn, until it touches the base of the exostosis. While keeping in mind the danger of injuring the tympanum and other delicate structures close by the chisel is given a few light taps which are generally sufficient to detach the tumor from the canal wall. If not, the chisel is withdrawn and reinserted to excise a small V-shaped portion of bone, thus forming an acute angle with the first until the base of the bony tumor is detached. Remove the fragments of bone with a forceps.
Step 5. Replace the flap. Pack the canal with gauze.

OPERATIONS FOR INFECTIONS OF THE MIDDLE EAR AND INTRACRANIAL COMPLICATIONS

MYRINGOTOMY

Anatomic Considerations. The tympanic membrane (Figs. 191 and 192). A thin, partly transparent membrane which divides the external auditory canal from the middle ear, running downward and inward obliquely with the lower anterior canal

walls. In pathologic conditions the marks of identification on the membrane are hidden but they must be kept in mind and not touched. It should also be kept in mind that the drum runs obliquely to the long axis of the canal and that the upper

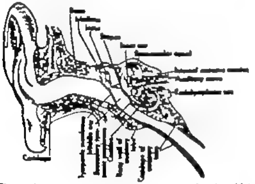


Fig. 191. Diagram showing relations of three subdivisions of ear. (Parsol—modified from Schwalbe.)

portion of the membrane is closer to the surgeon than the lower. The drum membrane is about 2 mm. external to the inner wall of the middle ear and at the back

Fig. 192. Drum membrane showing the relations of the landmarks to the small ossicles (viewed from behind).

portion is found the fenestra ovalis and stapes above and the fenestra rotundum below, which are usually protected by the wall of the posterior canal. The chorda tympani runs through the upper part of the middle ear. Prussak's space is almost completely

pletely separated from the cavum and if it is found necessary to drain this space the incision should be extended into the membrana flaccida and over the back fold. Sometimes the jugular bulb is exposed on the floor of the middle ear and at rare occasions in the canal. Shrapnell's membrane separates the facial nerve from the posterior and lower part of the middle ear. These anomalies occur infrequently to do not warrant any consideration. The lower part of the drum membrane is best for incision. (Fig. 193.)

Paracentesis tympani is indicated:
1. In acute otitis media, when the membrana tympani is red and bulging.
2. In acute otitis media, when the drum is red and the patient suffers severe pain.
3. In acute otitis media, when the membrane is red and when mastoid symptoms are present.
4. In subacute catarrhal otitis media, when fluid (mucus) persists in the middle ear.
5. In cases of otitis media, where resolution is delayed by obstructed drainage.

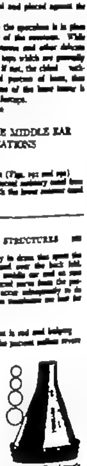


Fig. 194. Boucheron's ear speculum.

Operate under gas-oxygen anesthesia since this is a very painful procedure.

Introduce a large ear speculum (Fig. 194) and obtain brilliant illumination of the tympanic membrane.

Step 1. Make a long curvilinear incision beginning below at the most dependent part of the ear drum and hugging the posterior border extending upward to the posterior fold. An inexperienced man should make the incision at the point of greatest bulging, from the umbo downward to the floor of the canal. Such an incision will serve for all intents and purposes. (Fig. 193.)
Step 2. Pass the knife through the entire thickness of the drum but not so deep as to injure the mucous membrane of the inner wall.

Comment. The dangers of myringotomy are: dislocation of the stapes, perforation of the fenestra ovalis owing to inexperience or when the drum is incised from above downward instead of from below upward, and the knife is carried too far inward at the start engaging the stapes and tearing it out of the oval window.

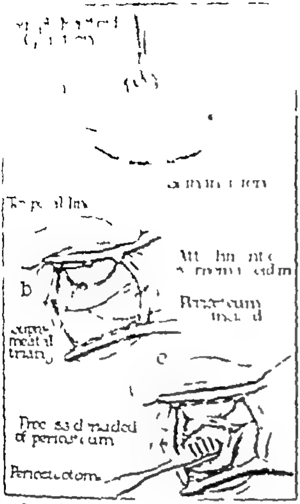
While these phases of surgical intervention require special training, on occasion, the general surgeon is forced to act in an emergency. Keeping such contingencies in mind, the author feels the general surgeon should be acquainted with the principles underlying the problems under consideration.

MASTOIDITIS

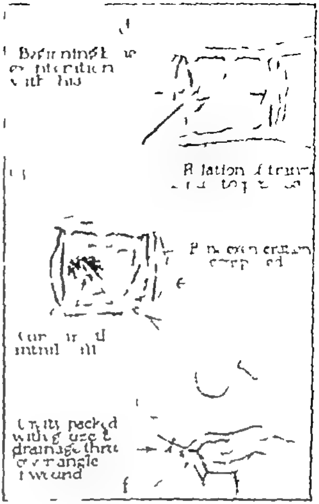
Operation for Acute Mastoiditis

Opening out from the middle ear is a series of air cells which occupy the mastoid process. This mastoid process frequently becomes the seat of suppurative processes associated with middle ear disease. (Fig. 195 A and B.)

Step 1. Shave the scalp on the affected side for about one and one-half inches about the auricle. Prepare the skin with iodine and alcohol.
Step 2. Make an incision about ½ inch behind the auricle, parallel to the attachment of the auricle to the skin. This extends from the superior at-



[illegible] Operation for acute mastoiditis. Consult text for steps of operation.



[illegible] Operation for acute mastoiditis. Consult text for steps of operation.

[illegible] of the auricle to the tip of the mastoid process and is carried through the periosteum to the bone.

Step 3. The periosteum is loosened from the bone with a periosteal elevator, both forward and backward. Care must be taken not to strip the periosteum from the posterior canal wall. Superficial bleeding is controlled with hemostats and ligatures. A self-retaining mastoid retractor is inserted.

Step 4. A search is made for any fistulas caused by the escape of pus through the cortex. If this is found, the mastoid is entered through the fistula. If not, the cortex is removed just posterior to the posterior canal wall from the suprameatal spine of Henle to the mastoid tip. This can be done by chisel and mallet or with an electric burr. The air cells of the mastoid are found beneath the cortex; these are usually infected and contain pus. The [illegible] cells are curetted and the overlying cortex gradually taken away in such a manner that one is not working in depth. One must not go beneath the posterior canal wall anteriorly as there is grave danger of injury to the facial nerve. Posteriorly it is necessary to search for the [illegible] bone which forms the sinus plate, and superiorly the mastoid [illegible] is bounded by the hard plate of bone, the tegmen tympani, above which lie the dura and the brain.

Step 5. The operation is not complete until the mastoid antrum leading to the middle ear is found. This is located by going anteriorly and inward at the superior-anterior portion of the mastoid cavity. When the antrum is located, the entrance is enlarged, care being taken not to enter the middle ear, as there is danger of injuring the ossicles and destroying the hearing.

Step 6. The remaining cells are cleaned out with a curet in such a way that the whole mastoid is converted into one large smooth cavity. This includes the zygomatic cells, the posterior-superior angle cells and the retro-sinus cells, if any of these are present.

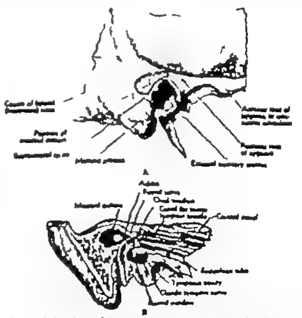
Step 7. The cavity is carefully cleansed of any bone chips. Iodoform packing is loosely inserted. The end of the packing is brought out in the lower portion of the wound, or a rubber drain is put in the lower part. The upper two-thirds of the wound is closed with silk or dermal sutures, the drain emerging from the lowermost portion. Vaseline gauze dressing is placed over the wound and auricle, dry gauze over this and a mastoid bandage applied.

Radical Mastoid Operation

Before proceeding to a radical mastoid operation, rule out suppurative labyrinthitis by appropriate tests. If this precaution is neglected, one is courting danger of meningitis should the labyrinth be involved in the suppurative process.

Anatomic Considerations. (Figs. 295 A and B.) The surgeon should have very clear picture in his mind concerning the surgical relationship existing between the facial nerve and the temporal bone. The facial nerve passes outward from the internal auditory canal until it reaches the upper anterior part of the inner wall of the middle ear just above and posterior to the canal for the tensor tympani muscle. It then passes backward in the inner wall of the middle ear above the fenestra ovalis to the point where it bends beneath the floor of the aditus, descending almost vertically in the posterior canal wall, emerging from the bone at the stylomastoid foramen. The anterior part of the external semicircular canal bears an important

relation to the vertical part of its course. The former points outward, over the facial nerve toward the surgeon so that [illegible] the posterior canal wall [illegible] lowered, the bone can be removed to an imaginary vertical line dropped downward from the anterior prominence of the external semicircular canal. The nerve runs through the aqueductus Fallopii, a canal of hard bone which is more delicate and the nerve more likely to be injured in the horizontal part of its course on the inner wall of



[illegible] A. Lateral view of the temporal bone showing the relations of the facial or [illegible] and mastoid antrum. B [illegible] temporal bone showing position of facial nerve and other important structures. ([illegible] Anatomy, [illegible])

the middle ear than in its vertical portion in the posterior canal wall. If suppuration has been present, many of the mastoid cells will have been obliterated, the bone will present a dense, ivory-like appearance and the antrum will be [illegible]. In cases of cholesteatoma, the bone beneath the cortex is apt to be soft and the cavities of the ear and antrum made larger. The external semicircular canal should be sought for after opening the antrum. It [illegible] a rounded [illegible] white, hard, solid bone and [illegible] usually easily discerned. In cases requiring radical operation, the lateral sinus is very apt to lie far forward, although its position is extremely variable. The fenestra ovalis and rotunda lie in the posterior part of the inner wall of the ear, anterior to the connecting point of the inner wall and posterior canal

During the radical operation, the fenestra ovalis, which lies just beneath the turn of the facial nerve cannot be plainly seen unless the facial ridge has been lowered to its extreme limit. It is usually covered by a mass of granulations that should not be disturbed. The promontory is the bone covering the first and second turns of the cochlea and appears as a rounded prominence on the inner wall of the middle ear anterior to the fenestrae ovale and rotundum. The Eustachian tube is observed as the hollow space formed by the anterior and inner wall, in the anterior part of the middle ear and is about 3 or 4 mm above the floor. The internal carotid artery is found toward the inner side and below the Eustachian tube, separated from it by a thin bony plate which often contains fissures; thus the carotid artery may be injured by careless curettage of the tube. Just above and parallel to the Eustachian tube is the canal for the tensor tympani muscle. The wall of bone between the two canals is often incomplete. The bony wall is extremely thin in the region where the horizontal part of the Fallopian canal is above and behind the canal for the tensor tympani and it is here that care should be taken not to injure the nerve. On the anterior surface of the bony plate forming the anterior osseous canal wall is found the glenoid fossa. This is sometimes entered when the canal is widened, but as a rule no harm results except a slight soreness and stiffness of the jaw. A serious septic arthritis may follow an injury to the synovial cavity.

The technic of a radical mastoid operation consists essentially of the following steps (Fig. 196):

Step 1. Incision.—This is the same as is used in acute mastoiditis plus elongation of the upper and lower extremity of the incision.

Step 2. Reflect the periosteum. Retract. Drape the margins of the wound. Illuminate thoroughly.

Step 3. Remove the cortex over the outer wall of the attic antrum and posterior wall of the canal for about one-eighth of an inch. In children this step may be omitted.

Step 4. Open the mastoid antrum as described above. In chronic suppurations this step is rendered more difficult because

(a) the osseous structures of the cortex are hardened and thickened,

(b) there is an apparent increase in depth and

(c) diminution of the size of the antrum.

Work slowly and carefully beginning at the posterior canal, working inward, forward and somewhat upward. Identify the antrum. Remove its overhanging walls. Orient yourself as to the position of the dural plate and plate of the sinus. In chronic cases there is a tendency for the dura to be low and the sinus situated forward. Remove all suspicious or diseased bone here and in the zygomatic region. Identify the external semicircular canal.

Step 5. Pass a probe from the antrum through the aditus into the middle ear. Remove all the wall of the canal above and extend the probe to the outer portion of the posterior canal (about one-third should be chiselled away). The remaining bridge is now bitten away by a delicate rongeur or by means of a chisel of appropriate size. Avoid injuring the facial nerve.

Step 6. Now lower the facial ridge by means of a chisel or burr. Fine shavings are taken away gradually. At this step an assistant watches the patient's face for twitching which would denote close proximity of the instrument to the facial nerve. External bleeding suddenly appearing may indicate that the artery of the facial nerve, which is here a very small vessel running in

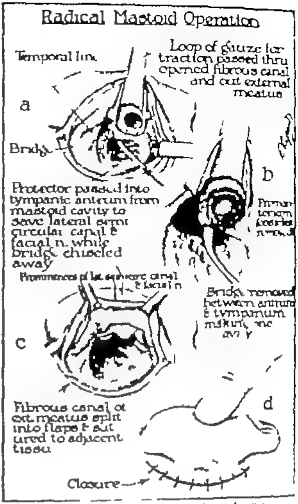


Fig. 196. Radical mastoid operation. (Consult text for steps of operation.)

the course of the nerve but somewhat external to it, has been divided. Compression usually will stop the bleeding.

Step 7. Remove the outer wall of the attic by means of a sharp bone curet. Remove the malleus and incus but be careful to avoid dislocating the stapes. Dry with appropriate-sized sponges. Oozing is controlled by a pledget of cotton dipped in adrenalin.

Step 8. Obliterate the hypotympanum.—Failure to remove this often results in failure of the operation.

Step 9. Gently curet out the mucous membrane of the Eustachian tube as far down as the isthmus. If this precaution is neglected, a permanent communication with the pharynx will result causing discharge and infection. Remember the close proximity of the carotid artery to the Eustachian tube. The canal for the tensor tympani muscle should also be obliterated.

Flush the large cavity with normal salt solution. Dry. Stay clear of the promontory and fenestra ovalis. Unnecessary manipulations here are often followed by labyrinthitis.

Step 10. This step consists of cutting a plastic flap in order to enlarge the external auditory canal and to line with skin the cavity created by the operation. A number of methods have been devised to accomplish this object.

Homer P. Todd describes his method as follows:

A. A long, narrow curved bistoury is passed down the meatus so that it projects through the detached end of the fibrous portion, its point being directed backward. The auricle is held well forward and the fibrous portion of the meatus cut through posteriorly from within outward, for a short distance.

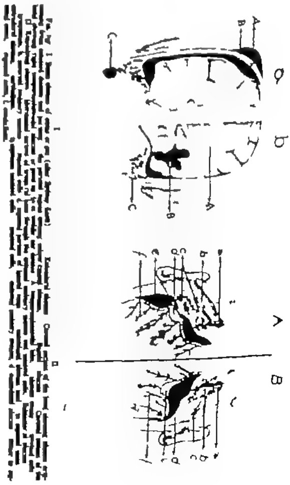
B. The edge of the bistoury is then directed in a slanting direction upward and outward, and the incision continued as far as the cartilaginous portion of the meatus, care being taken not to cut into the concha.

C. The bistoury is then withdrawn and reinserted at the point at which it was first made to turn upward. It is now directed downward and outward and, in a similar manner the incision is made in a slanting direction toward the lower margin of the cartilaginous meatus. (In carrying out these manipulations care must be taken that the outer portion of the bistoury does not injure the tragus or other portions of the auricle, a mishap which can easily occur.) The fibrous portion of the meatus is thus divided by a Y-shaped incision into three small flaps, namely, a posterior or external V-shaped flap, and a superior and an inferior flap.

D. The outer flap is fixed to the skin behind the auricle by means of a catgut suture. The auricle is then pulled back into its normal position. By inserting the tip of a finger into the meatus, the upper and lower flaps are pressed upward and downward against the roof and floor of the mastoid cavity and can be kept in position afterwards by suturing the flaps to the subcutaneous tissue or by packing the cavity through the meatus with a strip of ribbon gauze.

Step 11. Pack the cavity with iodoform gauze. The posterior wound is now closed.

Possible Intracranial Complications. (a) Cellulitis of the flaps. (b)



perichondritis (e) sinus thrombosis (d) facial paralysis (e) brain abscess (f) meningitis (g) acute labyrinthitis (h) postauricular fistula. Most of these may be avoided by proper technic.

EXTRADURAL ABSCESS

Step 1. Proceed as outlined for simple mastoid operation. Usually [illegible] is seen in the middle fossa tegmen surrounded by granulation tissue. The usually pulsating dura may or may not be seen emerging from the [illegible].

Step 2. Enlarge the fistula and remove the tegmen very carefully with rongeurs or curet. Extreme care must be taken in this procedure as any injury to the dura may lead to a fatal meningitis. (Fig. [illegible] and [illegible].)

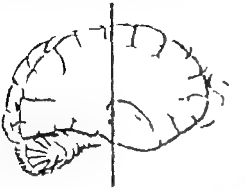


Fig. [illegible]. Temporosphenoidal abscess of otitic origin, [illegible] [illegible] [illegible] [illegible] line between [illegible] [illegible] [illegible].)

Step 3. Pack the mastoid cavity loosely. Do not close the wound.

Step 4. Bandage the same as in simple mastoid.

OPERATION FOR TEMPOROSPHENOIDAL ABSCESS

Step 1. Perform the radical mastoid operation as outlined.

Step 2. Expose the dura by removing the middle fossa tegmen quite widely in all directions. (Fig. [illegible].)

Step 3. With a small electrocoagulation tip make a circle about ½ inch in diameter in the dura; the cavity is packed loosely and bandage applied. The purpose of the electrocoagulation is to seal off the subarachnoid space in the region where the dura is to be incised.

Step 4. Twenty-four hours later remove the packing and make a small incision in the dura within the circle.

Step 5. Explore the brain with a Cushing needle; slight resistance will be felt when the capsule of the abscess is penetrated.

From this point of the operation there are two methods of procedure:

(1) A small catheter may be inserted along the side of the needle into the abscess cavity. The catheter may be used for irrigation or aspiration.

(2) The dural opening may be enlarged with a hemostat and a tract made into the abscess cavity. Insert a Mosher wire basket drain. Pack loosely and as the [illegible] heals the basket will be extruded.

OPERATIONS FOR SINUS THROMBOSIS

Anatomic Considerations. (Fig. [illegible].) The course of the lateral sinus may be outlined by a line drawn from the external occipital protuberance to the center of the external auditory canal. That part of the sinus below the bend or knee which

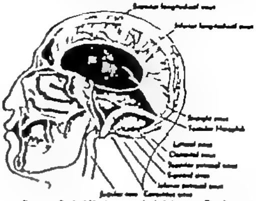


Fig. [illegible]. Cerebral blood sinuses. Applied Anatomy, Davis.)

arises in the posterior part of the mastoid bone, and which extends from the knee to the jugular bulb is called the sigmoid sinus. This portion of the sinus has no definite surface landmark because it may occupy a variable position on the inner surface of the mastoid bone. Beneath the middle ear the sigmoid sinus makes a sharp turn upward, and expands to form the jugular bulb. The knee of the sinus is joined by a small vein, the superior petrosal sinus. The sigmoid and lateral sinus [illegible] a large vein which runs on the inner surface of the mastoid process, and is covered by a thin process of dura mater. It is separated from the mastoid cells by a plate of bone of ivory-like whiteness and consistency, the so-called sinus-plate.

The operation is performed on patients affected by thrombosis without a preliminary exenteration of the mastoid process.

Step 1. The incision of a prolongation of the posterior incision toward the external occipital protuberance. Cut down to the bone, elevate the periosteum, check bleeding.

Step 2. Delineate the sinus plate by removal of the bony structure around its boundary. Use a sharp curet. Do not injure the sinus during this manipulation lest hemorrhage seriously interfere with the operation.

Step 3. Remove the bone over the posterior part of the sinus plate. If hard, use a chisel; if soft, a sharp curet.

Step 4. Remove the sinus plate with powerful rongeur forceps. A grooved director is inserted between the plate and the sinus to avoid injuring it. This is an important step and must be carried out with care and gentleness. The sinus is then bared of plate on top and on its sides to the extent desired.

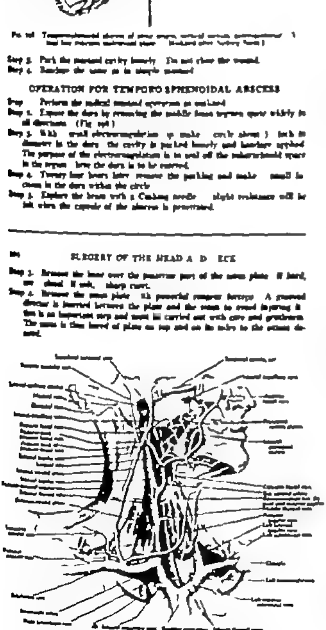


Fig. [illegible]. Diagram showing deep veins of neck and head.

Step 5. An assistant compresses the upper and lower segments of the sinus with iodoform plugs of appropriate size held in forceps, while the surgeon opens it in its long axis with a scalpel to the length desired. When the sinus is opened and

(a) there is no bleeding, there is a clot at its interior. When (b) there is free bleeding, determine its source. Make pressure on the jugular end. If bleeding ceases there is a clot at the torcular end. If bleeding continues slightly it comes either from the mastoid emissary vein (superior petrosal sinus) or partially obstructed torcular end. Exert pressure on the torcular end, release the pressure from the jugular end. No hemorrhage indicates a clot in the jugular

end of the sinus. Slight bleeding indicates partial clotting. Free bleeding does not exclude clot, for the blood may come from the inferior petrosal sinus. If there is a clot at the torcular end, endeavor to dislodge it gently with a dull curet. If unsuccessful open the sinus further until you find the clot and free bleeding takes place.

A firm clot at the jugular end is an indication to stop operative manipulations and to proceed to ligate, or excise the internal jugular vein. If clot can be removed and free bleeding takes place some surgeons wait 24 hours. If no septic symptoms are present, the clot is removed with a dull curet and the sinus packed with iodoform gauze.

Step 6. Trim the edges of the open sinus, pack it with iodoform gauze. Pack the mastoid wound as usual. In packing the sinus, do it gently; remember too much pressure may cause injury to the contiguous brain. Leave the packs in situ for 5 days. If on removing the packs bleeding recurs, pack again.

LIGATION AND RESECTION OF THE INTERNAL JUGULAR VEIN

Anatomic Considerations. (Fig. [illegible].) The internal jugular vein is the continuation of the lateral (transverse) sinus, and begins in the postero-external compartment of the jugular foramen. It descends vertically at first on the outer side of the internal carotid, and subsequently on the outer side of the common carotid, and ends behind the inner end of the clavicle by joining the subclavian vein to form the innominate vein. In the upper part of its course, the vein rests upon the rectus capitis lateralis and the transverse processes of the upper cervical vertebrae. It is crossed by the spinal-accessory nerve, the posterior belly of the digastric and the stylohyoid muscles, and also by the occipital and posterior auricular arteries. It is overlapped lower down by the anterior border of the sternomastoid, and is crossed opposite the cricoid cartilage by the anterior belly of the omohyoid. The terminal part of the vein, which lies deeply between the sternal and clavicular heads of the sternocleidomastoid, under cover of the infrahyoid muscles, passes in front of the first part of the subclavian artery. During its course, the vein receives the inferior petrosal sinus, the common facial, the lingual, the pharyngeal and the superior and inferior thyroid veins.

Place a sandbag under the patient's shoulders. Turn his head to the opposite direction.

Step 1. Make an incision along the course of the sternocleidomastoid muscle beginning about half an inch from the mastoid process and extending to the clavicle. The scalpel divides the skin, subcutaneous tissue and platysma muscle. (Fig. [illegible].)

During this manipulation the external jugular vein is encountered; ligate and divide it.

Step 2. Locate the anterior border of the sternomastoid muscle. Retract it. Separate the delicate layer of the deep cervical fascia. The common carotid sheath embracing the common carotid artery, the internal jugular vein and the pneumogastric nerve will be exposed. The vein is external, the artery internal and the nerve posterior in position. The vein is bluish in color and expands with the respiratory movements.

Step 3. Open the carotid sheath in the region of the omohyoid muscle.

doing avoid injury to the vein. Open the sheath of the vein by gentle dissection from the omohyoid below to above the entrance of the facial vein. *Dissect the vein bluntly from its posterior attachments. Avoid injury to the pneumogastric nerve.* Ligate and divide the large venous branches entering the vein (middle and superior thyroid, lingual, facial and occasionally branch from the external jugular vein).

Step 4. After sufficient exposure of the vein has been obtained, ligate it doubly below and divide it between the ligatures.

Fig. [illegible]. Incision for ligation and excision of internal jugular vein. Line of incision.

Step 5. Deliver the upper trunk of the vein into the wound as high as possible, ligate it doubly with plain catgut above and divide it below the ligature. Ligate branches as encountered.

Step 6. Irrigate the cavity with normal salt solution. Insert a cigarette drain in the stump above and another drain into the lower angle of the wound. Suture the platysma and deep fascia with interrupted plain catgut sutures.

Step 7. Close the wound and dress securely.

CHAPTER 10

SURGERY OF THE FACE

INFECTIONS

CARBUNCLE OF THE FACE

The favorite location for this lesion is the upper lip. Death occurs in many cases; the fatality is preceded by the formation of a blood-clot in the cavernous sinus.

One or both angular veins are ligated under local anesthesia as a means of preventing the spread of the infection. (*Fig. [illegible]*.)

The resistance of the patient is sufficient in some cases to control the spread of the infection.

Caution. If the temperature rises and edema appears and extends from the lip to the inner canthus of the eye accompanied by swelling of the eyelids, do not hesitate—act.

Half an hour before the operation, administer hypnotic.

Step 1. Drop castor oil into the eye and cover the eyelids with damp gauze so that no iodine can reach the conjunctiva.

Step 2. Cover the lip with gauze dampened with perchloride solution. The junction of the nose and cheek forms the external marking for the angular vein.

Fig. [illegible]. Ligation of angular vein. [illegible]

Step 3. After the area has been anesthetized, make an incision about an inch long, beginning [illegible] below the inner canthus of the eye and extending downward slightly obliquely. Gauze saturated with adrenalin will control oozing.

Step 4. Inject more novocaine about the tissues and expose the levator labii superioris alaeque nasi muscle through the wound. Carefully separate the fibers of the muscle in or between which is found the angular vein.

Step 5. Ligate the vein and divide it between ligatures. Suture the skin and apply dressing.

X-ray Treatment of Furuncles and Carbuncles

Considerable has been written lately in the current medical journals of x-ray therapy in certain types of inflammatory lesions. Especially good results have been obtained in furuncles and carbuncles. All authors agree that such lesions should be treated early and the dose of x-ray must be small.

Furuncles. In acute furunculosis, dose of [illegible]

[illegible] voltage of [illegible] to [illegible] kvp, is administered over the inflammatory area blocking out the normal surrounding tissues. By such treatment early undeveloped lesions may be completely aborted in [illegible] to [illegible] hours. Relief from pain often occurs in [illegible] few hours. In chronic furunculosis better results are had with [illegible] filtered ray [illegible] [illegible] kvp, [illegible] mm of aluminum may be given every [illegible] week for several treatments if necessary.

Carbuncles do not respond quite so well as furuncles to [illegible] ray therapy. A somewhat larger dose is indicated [illegible] [illegible] [illegible]. Filtered rays are better because the lesion [illegible] deeply [illegible]. With this form of

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Patient [illegible] years of age [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

Fig. [illegible]. Same patient after treatment [illegible] [illegible]

therapy the course is definitely shortened, drainage [illegible] increased and pain often relieved.

X-rays have no bactericidal effects. The modus operandi resulting in the changes as [illegible] result of irradiation is not definitely known. We do know however that leukocytes and lymphocytes are very sensitive to [illegible] rays and as [illegible] result of their premature destruction some type of antibody may be liberated or [illegible] metabolic change occurs which is antagonistic to the invading micro-organisms.

ACTINOMYCOSIS OF THE FACE

As [illegible] prophylactic and cure, roentgenotherapy proved unsuccessful in treating actinomycosis of the face. The iodides administered internally seem to possess some merit and the internal use of iodides combined with surgery seem to meet the situation best. So-called "lumpy jaw" seems to have the best chance for recovery. The microscope confirms the diagnosis. If all apparent infiltration is eliminated, [illegible] cure may be effected. If the condition does not yield to conservative measures (treatment) complete excision should be done regardless of the disfigurement it may cause. (Figs. [illegible].)

Dark and irregular portions of skin and subcutaneous tissue often harbor [illegible] and pus pockets. The infected areas should be incised to the deepest

points and recesses of infiltration. Sinus tracts and abscesses should be curetted thoroughly and the cavities painted with tincture of iodine. Such operations may require repetition.

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. [illegible] of the face [illegible] [illegible] months of age.

Fig. [illegible]. Same patient [illegible] years after radium treatment. (Courtesy of Dr. [illegible].)

TUMORS OF THE FACE

Hemangiomas are best treated by radium (Figs. [illegible]). Occasionally, epitheliomas of the face heals [illegible] much better by the same treatment than is removal with the scalpel (Figs. [illegible]).

PLASTIC REPAIR OF DEFECTS OF THE CHEEK (*MELOPLASTY*)

A multitude of operations are advised for the repair of loss of substance of the cheek from one cause or another. (Figs. [illegible], [illegible], [illegible].) Of these may be mentioned simple suture, and the use of pedunculated flaps from the frontal, temporal, maxillary or submaxillary region. Such operations are often beset with many difficulties. (Figs. [illegible], [illegible], [illegible].) Failures often result from insufficient blood supply and infection. No given method will suit all cases. Careful selection is essential. [illegible] type of procedure aiming at supplying surfaces the following will serve the purpose.

DEFECTS WITHOUT CICATRICIAL MAXILLARY OCCLUSION

[illegible]

Step [illegible]. Dissect up the cheek freely on each side of the defect. The detachment should be more lateral below than above in order to avoid undue displacement of the eyelids.

Step . Accurately unite the lines by interrupted sutures.

If this fails recourse should be had to the following procedure.

Step . Outline a single flap having a broad pedicle. Turn the flap forward on its pedicle in such a manner as the skin surface is toward the interior of the mouth. It is well to leave the pedicle attached a little distance behind the posterior margin of the defect.

Step . At the end of about two weeks sever the flap. Use any remaining portion of tissue to cover part of the area from which the flap was taken.

Fig. . Fig. .

Fig. . Epithelioma of the face before treatment.

Fig. . Epithelioma of the face after radium treatment. Partially built up plastic (courtesy of Dr. Frank E. Simpson).

Step 3. Cover the external surface of the flap with skin grafts or a superimposed flap from the closest lower down (jaw, neck).

Step . Later reshape the angle of the mouth.

In case of large defects resort to

SMALL OPERATION

Step . Make a very long pedunculated flap, taken from the neck and reaching from the front of the ear to the maxillary angle as far down as the clavicle if deemed advisable. This flap is to replace the mucosa (Fig.).

Step 2. Attach the flap to the margins of the defect with its skin surface facing toward the interior of the cheek.

Step 3. Close the wound in the neck (Figs. ,).

Step 4. Between the second and third week following the previous step, divide the pedicle and turn it on itself over the raw surface of the healed flap, the skin side now facing outward. Suture it into place.

Step 5. Reshape the angle of the mouth.

OTHER PROCEDURES

Pedunculated flaps from the forehead enclosing the temporal artery.

2. Flaps from the arm (Lexer).

3. Flaps from the chest (Hahn).

Immediate closure of a defect following excision of a tumor of the mucous membrane by using the mucous membrane at the base of the tongue (Wood—) and (Willard Bartlett—).

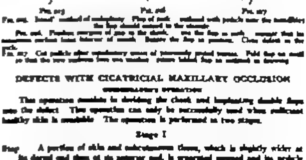


Fig. . Fig. . Fig. .

Fig. . Israel's method of . Flap of neck outlined with pedicle near the mandibular ; the flap should extend to the clavicle.

Fig. . Position margins of flap to the cheek, . . . the flap so that its mucous surface faces interior of mouth. Suture the flap in position. Close defect in the neck.

Fig. . Cut pedicle after satisfactory union of internally placed tissue. Fold flap on itself so that the two surfaces face one another. Suture folded flap as outlined in drawing.

DEFECTS WITH CICATRICIAL MAXILLARY OCCLUSION

COMPENSATORY OPERATION

This operation consists in dividing the cheek and implanting double flaps into the defect. This operation can only be successfully used when sufficient healthy skin is available. The operation is performed in two stages.

Stage I

Step . A portion of skin and subcutaneous tissue, which is slightly wider at its dorsal end than at its anterior end, is separated upward and its pedicle placed at the anterior border of the masseter muscle. The cicatricial tissue is dissected from before backward and the mouth widely opened.

Step 2. The skin flap is turned into the imperfection in such a manner that its free anterior margin is inside the mouth; its edges are stitched to the edges of the defect and the deep surface of the flap is sutured to the inner aspect of the internal pterygoid muscle.

Stage II

Step 3. After about four weeks the pedicle is separated and the posterior of the flap is carried into the anterior part of the defect and sutured.

reflected margins. In this way the skin surface of the flap is directed toward the mouth, and the exposed raw surface is covered by a superimposed flap taken from the lower jaw.

INJURIES TO THE BONES OF THE FACE

FRACTURE OF THE UPPER JAW

Direct injury may result in a partially or completely fractured process of the superior maxilla, the malar bone may be forced into the antrum, or the jaw may be separated along the midline. The prognosis in most cases is favorable, about five weeks being required for complete recovery. Callus formation is slight. Occasionally it becomes imperative to remove the tear duct. Displacement of the fragments often tax the surgeon's skill to insure alignment so that a deformity will not result. Remove no fragments unless imperative (infection, necrosis). Have a skilled dentist apply an interdental splint.

LOTHROP'S OPERATION

Step 1. General anesthesia (preferably rectal). Have the patient in a sitting position.

Step 2. Draw the cheek back from the teeth. Incise the mucous membrane at the upper margin of the alveolar process to the extent of about an inch, detaching the incision from the canine ridge backward.

Step 3. Separate the bone from the soft tissues of the cheek with a periosteal elevator.

Step 4. After the fracture-fissure has been located by the surgeon's finger, introduce a probe into it and with it raise the fractured portion of bone into its normal position.

Step 5. Where the fissure cannot be located, force the probe into the antrum immediately over the second bicuspid tooth and raise the broken wall of the antrum. If the probe does not seem strong enough to accomplish the desired result try a No. [illegible] to [illegible] French male urethral sound, inserting it on top of the probe which is used as a guide.

Step 6. Introduce one or two small gauze drains into the deepest portion of the wound; remove the drains in one or two days. Irrigate the mouth frequently with chlorated sodium solution or some other mild antiseptic. If the face is swollen, apply hot, wet boric acid dressings.

Instruct the patient not to touch the affected side or lie on it, in order to avoid displacing the fragments.

FRACTURE OF THE MALAR BONE

Steps [illegible] to 3. These are the same as those in the foregoing procedure.

Step 4. Introduce a urethral sound (No. [illegible] to 24 French) into the apex of the antrum where it joins the malar bone. Have an assistant steady the patient's head while the surgeon holds the sound in both hands, his left hand serving as a fulcrum, holding the sound near the curve and his right hand grasping the handle.

Step 5. Exert firm pressure upon the fragment; push it back into its normal position. Detached portions of bone are removed with forceps.

Drain into the mouth. Order liquid diet for a week, and general treatment as in Lothrop's operation.

FRACTURE OF THE ZYGOMA

The main objective is usually to correct deformity.

Step 1. General anesthesia. Make an incision with its center over the depressed fragment.

Step 2. Retract the soft tissues from the bone with proper retractors.

Step 3. Replace the fractured fragments of bone by manipulation. It generally will remain in position. If not, suture it to the sound part of the bone.

Step 4. Close the wound. Apply dressings in such a manner that no pressure is exerted upon the incision (opening in the center of the dressing). In uncomplicated cases, healing takes place in about two weeks. Do not permit the patient to lie on or manipulate the affected side of the face.

OPERATIONS ON THE DIVISIONS OF THE TRIGEMINAL NERVE AND THE GASSERIAN GANGLION

TRIGEMINAL NEURALGIA (TIC DOULOUREUX)

Anatomic Considerations. (Fig. [illegible].) The trigeminal (fifth) nerve comprises two roots (motor and sensory). These are connected to the anterior surface of the pons Varolii. From here they pass forward to the apex of the petrous portion of the temporal bone, where the sensory root becomes flattened and joins the Gasserian (semilunar) ganglion lying on the apex of the petrous portion of the temporal bone where it is enclosed by a thin walled recess of the dura mater (Meckel's cave) to which it is partly adherent. From the anterior border of the ganglion arise the three divisions of the nerve: (1) the ophthalmic, (2) superior maxillary and (3) the mandibular.

The number of injections necessary for relief depends on the accuracy with which the alcohol is placed; one injection within the nerve sheath will suffice to stop the pain at once. An injection near but not in the nerve is not without value because the alcohol undoubtedly diffuses sufficiently to reach it; relief comes after some minutes or hours but does not last long. Hence it is wise to continue the injections even though the patient is having no pain, until the characteristic sensory phenomena (pain and feeling of swelling and numbness in the area supplied by the nerve; analgesia in area) announce marked action on the nerve. If pain returns there is no objection to secondary injection.

Treatment by Injection

Usually 80 per cent alcohol is used for injecting the affected nerve and from [illegible] cc. are deposited directly into the nerve trunk. The object is to destroy the nerve by producing degeneration and absorption of the nerve structure except its membranes. (Figs. [illegible].)

The site of point of entry of the needle is anesthetized with some local anesthetic (novocaine [illegible] or 1 per cent). A special needle of considerable length and strength is required. It should be graduated indicating centimeters and supplied with a stylet capable of extending to the point of the needle. The attachable syringe should be of from [illegible] cc. capacity. (Figs. [illegible].)

Step 1. Locate the position of the affected nerve trunk. Do not incise the skin.

Step 2. Introduce the needle slowly; steadily push it onward toward the nerve until its sheath is entered; this is usually manifested by a sensation of pain felt by the patient, which radiates over the entire course of the peripheral distribution of the particular nerve.

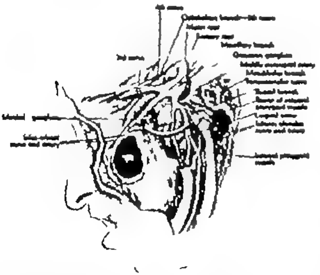


Fig. [illegible]. The fifth or trifacial nerve with its various branches. (Davis, Applied Anatomy.)

Step 3. Withdraw the stylet, adjust the syringe to the needle and inject the alcohol into the nerve slowly and steadily. Detach the syringe and leave the needle in position for a minute or two and then withdraw it slowly. Seal the puncture point with collodion or sterile zinc oxide plaster.

OPHTHALMIC NERVE (LEVY-BAUDOUIN METHOD)

The first branch of the fifth nerve divides inside the cranium, hence it is difficult to attack its trunk. The nasal route is scarcely accessible on account of the important motor nerves which surround it. The orbital route is indicated to reach the frontal and lachrymal nerves. Insert the needle at the external wall of the orbit at the level of the inferior extremity of the external angular process of the frontal bone, pass it below the lachrymal gland and follow the direction without injury to the eye or to any important organ. The injection

is made at a depth of 35 or 40 mm. after withdrawing the needle. The patient should have his eyes closed. The needle has some difficulty in penetrating the outer portion of Tenon's capsule which is very thick.

SUPERIOR MAXILLARY NERVE (SCHLÖSSER'S METHOD)

Step [illegible]. Draw an imaginary line vertically downward beginning at the external angular process of the frontal bone. Introduce the needle directly under the zygoma where this line crosses its inferior margin. The needle is inserted somewhat upward and inward until it comes in contact with the back of the superior maxilla.

Fig. [illegible]. Position of the patient in approach to the branches of the Gasserian ganglion for alcohol treatment.

Step [illegible]. Using the maxillary bone as a guide, push the needle on until its point has penetrated about [illegible] inches ([illegible] cm.) or slightly more, from the point of entrance [illegible] surface of the malar bone and has reached the foramen rotundum. [illegible] and approach of the superior dental nerve is shown in Fig. [illegible], p. [illegible].

SUPERIOR MAXILLARY NERVE (OFFERHAUS' METHOD)

The needle is introduced at a chosen point in the middle of the upper edge of the zygoma and pushed directly inward until the squamous portion of the temporal bone or the great wing of the sphenoid is struck and directed by these parts over the foramen ovale at a depth of [illegible] inches ([illegible] cm.) from the outer surface of the zygoma.

INFERIOR DENTAL OR MANDIBULAR NERVE

The nerve may be blocked as it leaves the skull at the foramen ovale, but the most desirable point of entry for the needle seems to be inside the lower

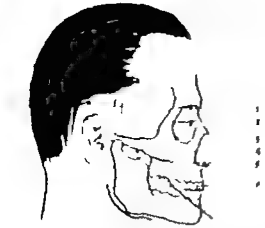


Fig. [illegible]. Points of insertion for blocking the various branches of the trigeminal. [illegible]

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Medial and lateral position of the needle for blocking the branches of the first division of the trigeminal nerve.

Fig. [illegible]. Position of the needle for blocking the second division of the trigeminal at the pterygopalatine fossa through the orbit. The needle [illegible] inserted to the inferior orbital fissure.

Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible]. [illegible] Direction of [illegible] needle through the cheek to [illegible] the Gasserian ganglion. According to Härtel [illegible]

Fig. [illegible]. [illegible] Block anesthesia of the second and third branches of the trigeminal nerve by an external approach. The needle [illegible]

Fig. [illegible]. [illegible] Direction of [illegible] needle through the cheek to [illegible] the Gasserian ganglion. Same as preceding lateral view showing the direction of the needle so that [illegible] the articular tubercle. After Härtel.

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Blocking the third division of the trigeminal at the foramen ovale. The needle [illegible] [illegible]

Fig. [illegible]. [illegible] blocking by subcutaneous infiltration across the forehead and the eyebrows.

jaw near the lingula. A long needle is used for this injection. (Figs. [illegible], [illegible].)

Step [illegible]. The needle should be entered near the canine tooth, directed parallel to the biting surface of the teeth across the mouth until the bone [illegible] reached after [illegible] which is the nearest [illegible] over the nerve. The bone [illegible] then followed posteriorly until the needle reaches [illegible] point immediately in front of the lingula [illegible].

Step [illegible]. Five to ten cc. of [illegible] per cent solution of [illegible]-adrenalin solution is sufficient to anesthetize the corresponding half of the lower jaw and about half of the tongue. Injection of the needle in the mental foramen under the first and second bicuspid teeth, will produce anesthesia in the anterior branches of the nerve.

According to Braun, the most direct way of reaching the foramen ovale is from the outside. By inserting the needle immediately under the border of the zygoma and carefully observing the suggestions of Offerhaus, the anesthetic solution is almost certain to be injected into the trunk of the mandibular nerve as it leaves the skull. After carefully measuring fifty skulls Offerhaus discovered that the connecting line of the articular tubercle is [illegible] to the maxillary [illegible] and divides the two points [illegible] short distance below and usually the same distance [illegible] from both foramen ovale. Since the mandibular nerve is directed forward and downward after leaving the skull, the intertubercular line [illegible] these nerve trunks exactly at the foramen ovale. (Fig. [illegible], p. [illegible].)

OFFERHAUS METHOD

Step [illegible]. A [illegible] marks the articular tubercle on the side to be injected and [illegible] pencil marks the point on the opposite side. With an ordinary compass, measure, externally the length of the alveolar process of the maxilla back of the last molar tooth and measure the length of the intertubercular line with an Offerhaus compass. For instance, if the measurements are [illegible] and [illegible] cm. the points will be [illegible] cm. from the point at which the needle should be inserted.

Step 2. By placing [illegible] small cork on the needle about [illegible] cm. beyond the desired length the surgeon is able to determine how far the needle should be inserted—it should be inserted no further.

Step 3. The needle [illegible] inserted in the direction indicated by the points of the Offerhaus compasses which have been placed on the head; the patient will experience pain in the lower jaw at this point. The thick nerve trunk offers resistance to the needle here although at times [illegible] can be penetrated.

Step 4. If the needle has entered the nerve trunk [illegible] per cent novocaine-suprarenin solution [illegible] if the needle enters near the nerve trunk [illegible] cc. are necessary. Blocking of the nerve often takes place in an instant although never more than [illegible] or [illegible] minutes are required.

[illegible] METHOD

The method of injection of the foramen ovale [illegible] supposed to be simpler than the above.

Step [illegible]. Insert the needle [illegible] skull which is marked by [illegible] as a held beside the patient to determine the direction.

Step 2. After being inserted 4 or 5 cm. the needle reaching the pterygoid process and is then about [illegible] cm. from the foramen ovale, the movable piece of cork marking the distance on the needle.

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Infiltration blocking of the inferior dental nerve. External approach.

Fig. [illegible]. Infiltration anesthesia of the inferior dental (mandibular) nerve. Intra-oral approach.

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Infiltration anesthesia of the superior dental nerve. Intra-oral approach through the mental foramen.

Fig. [illegible]. Infiltration anesthesia of the inferior dental nerve. Extra-oral approach (at the mental foramen).

Step 3. After retracting the needle as far as the subcutaneous tissue it is again inserted at [illegible] slight angle to the same depth or deeper. The patient now complains of the usual radiating pains.

Comment. The complexity of this method may be further [illegible] by determining the exact depth of the foramen ovale. Few utilize [illegible] methods while inserting the needle but direct it back further than

been in his search for the base of the pterygoid process. The needle is then directed a little posteriorly and 5 to [illegible] cm. deeper than the distance first figured. Undesirable secondary effects such as hematoma, etc., need not be feared if the foramen ovale is injected from without.

In case the injection of alcohol or other substance (osmic acid) fails to relieve the symptoms, neurectomy is resorted to.

Neurectomy

NEURECTOMY OF THE SUPRAORBITAL NERVE

Step 1. Locate the supraorbital notch or foramen. Make a horizontal incision parallel to and a little below the eyebrow. (Fig. [illegible])

Step [illegible]. Separate the fibers of the orbicularis palpebrarum muscle. Retract the divided tissues and expose the nerve as it passes through the supraorbital notch.

Step 3. Isolate the nerve for a short distance. Seize the undivided nerve trunk with a pair of narrow bladed hemostats and twist the hemostat in such manner that the nerve is wound round it. Reverse the direction of rotation. Work slowly. Repeat the procedure as often as is necessary until all of the peripheral portion of the nerve and a section of its central part are avulsed. Close the wound. Dress. (Fig. [illegible])

[illegible] OF THE INFRAORBITAL NERVE

Anatomic Considerations. The superior maxillary nerve originates at the middle of the Gasserian ganglion. It passes horizontally forward and leaves the skull through the foramen rotundum of the sphenoid bone. It crosses the spheno-maxillary fossa. Here it becomes the infraorbital nerve and enters the infraorbital canal of the superior maxilla through which it reaches the face to break up into several branches. To locate the infraorbital foramen, draw a line from the supraorbital notch to the interval between the two lower bicuspid teeth. About half an inch below the lower margin of the orbit and along the line described, the infraorbital foramen is located. The nerve may be resected (a) at the infraorbital foramen or (b) at the foramen rotundum (more difficult to perform but more satisfactory in results).

RESECTION OF THE INFRAORBITAL NERVE AT THE INFRAORBITAL FORAMEN

Step [illegible]. Raise the head of the patient on a sandbag or pillow. Turn the head slightly toward the affected side. Locate the infraorbital foramen as suggested above.

Step 2. A slightly curved incision about half an inch in length is now made running parallel and close to the lower margin of the orbit. The incision [illegible] slightly concave as it is directed upward and is so planned that its center will cross the infraorbital foramen. (Fig. [illegible])

Step 3. Divide the orbicularis palpebrarum muscle in a direction parallel to its fibers. The levator labii superioris (caput infraorbitale) is now exposed and it also is split in the direction of its fibers.

Step 4. Elevate the periosteum from the floor of the orbit exposing the infraorbital nerve in its canal. As it leaves the infraorbital foramen the infraorbital nerve divides into a number of branches. Seize the nerve in a [illegible]

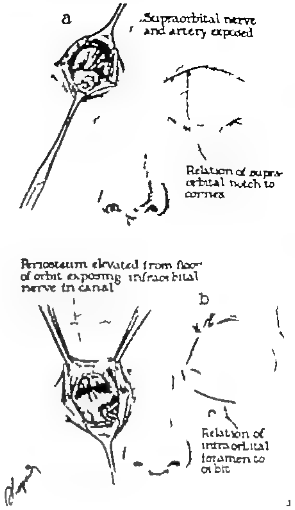


Fig. [illegible] [illegible] Neurectomy of the supraorbital nerve. b, neurectomy of the infraorbital nerve.

[illegible] bladed artery forceps and by traction and torsion extract as much of its trunk from its bony canal as is possible. With the patient at ease a great portion of the nerve may thus be avulsed.

There is often considerable hemorrhage due to injury to the infraorbital artery and vein. An adrenalin tampon will control the bleeding.

Step 5. In order to prevent a recurrence of the neuralgia, plug the bony canal, with a bone peg, silver screw, etc. This operation is not so successful as the removal of the nerve. This may be accomplished at the foramen rotundum. With the nerve Meckel's (sphenopalatine) ganglion is also removed.

RESECTION OF THE INFRAORBITAL NERVE AT THE FORAMEN ROTUNDUM

(See Fig. [illegible], p. [illegible])

Step 1. In this procedure the nerve must be followed up through the superior maxillary bone to the foramen rotundum. Make a horseshoe incision that commences just below the inner edge of the infraorbital margin and runs obliquely downward and outward to the lower angle of the malar bone. The incision should be ample enough to give good exposure of the anterior surface of the superior maxilla from the canine fossa to the lower margin of the orbit.

Step [illegible]. Separate the fibers of the levator labii superioris (caput infraorbitale). Expose the nerve at the infraorbital foramen as in the previous operation.

Step 3. Surround the nerve with a ligature for identification and traction. Clear the anterior surface of the superior maxilla of muscles and periosteum.

Step 4. Chisel away a square opening, the sides of which should be about an inch in length. This opening is so planned that the infraorbital opening [illegible] slightly below the center of the square and the upper edge is to be just below the margin of the orbit. During the chiseling watch the nerve constantly and avoid injuring [illegible]. It is left hanging through the opening.

There is usually a considerable oozing after the antrum of Highmore is opened. Pack the wound with small cotton tampons dipped in a [illegible] adrenalin solution. Do not proceed with the operation while oozing continues.

Step 5. When the field is clear, illuminate the area with a head mirror and remove the lower wall of the antrum with a fine chisel. Guard the nerve. If it be torn, the guide for further steps will be lost.

Step 6. After the entire floor of the infraorbital canal has been chiseled away as far back as the posterior wall of the antrum, a slightly smaller opening [illegible] created on the posterior wall of the antrum. The nerve now protrudes through the openings made.

Step 7. Dry the field. Pull the nerve taut. Trace it to the foramen rotundum. Identify Meckel's (sphenopalatine) ganglion. Grasp the nerve with a pair of forceps near the foramen rotundum, pull it out forcibly or divide it flush at the foramen with a pair of scissors. In either procedure the ganglion [illegible] come away with the trunk of the nerve. Pull the nerve out of the foramen as much as possible. Attend to hemostasis. Unite the structures. Drain. Close the skin wound. Dress.

NEURECTOMY OF THE THIRD DIVISION OF THE TRIGEMINAL (FIFTH) NERVE

Anatomic Considerations. (Fig. [illegible]). The third or inferior maxillary (mandibular) division of the fifth nerve leaves the skull through the foramen ovale and divides into two main branches, the anterior (smaller) giving off the following branches, the masseteric, buccal and external pterygoid. From the posterior (larger) the following branches are derived, the auriculo-temporal, lingual and inferior dental

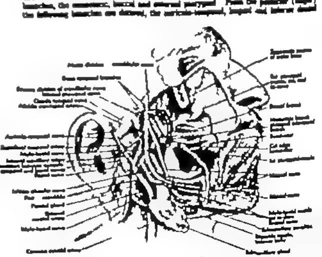


Fig. [illegible]. Dissection showing mandibular nerve [illegible] its branches, [illegible] has been partially removed, exposing inferior dental nerve in its canal.

(alveolar). Oftentimes, in neuralgia of the third division of the trigeminal, neurectomy fails and removal of the Gasserian ganglion has to be resorted to. The lingual and inferior dental nerves have a close surgical relationship. They are generally completely involved if either of them is affected by neuralgia. Their excision may be considered as part of one operation.

Step [illegible]. Make a curved incision around the angle of the jaw. Displace the supramaxillary branch of the facial nerve downward. Respect the facial artery.

Step [illegible]. Separate the masseter muscle with a periosteal elevator and slight traction of the knife. Trephine an opening in the center of the ascending ramus of the inferior maxilla (Velpeau's rule). If necessary, the trephine opening should be enlarged with appropriate rongeur forceps. Pull out the nerve by twisting about a clamp.

The nerve may also be reached by exposing the mental foramen (Fig. [illegible])

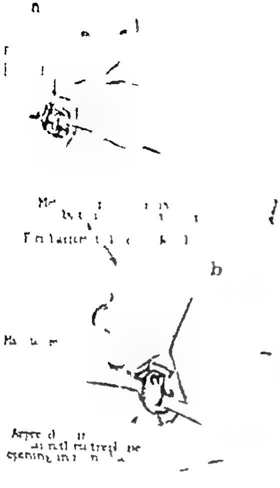


Fig. [illegible]. [illegible] of the inferior [illegible] (mandibular) nerve.

[illegible] the second [illegible] tooth. This approach, as will be seen, [illegible] or less scarring. The nerve may be reached through an internal approach. This [illegible] of course [illegible] in many respects preferable.

[illegible]

Step 1. Open the mouth of the patient widely [illegible] mouth gag. Good [illegible] is essential. [illegible] the tip of the tongue with [illegible] suture. This [illegible]. Keep the tongue out of the field of operation.

Step [illegible]. [illegible] one inch long [illegible] with the anterior border of the [illegible] ramus of the mandible. Separate the [illegible] from the bone.

Step 3. Expose the inferior [illegible] (mandibular) spine [illegible] above the commencement of the inferior dental (mandibular) canal.

Step 4. [illegible] blunt-pointed scissors [illegible] the long internal lateral (sphenomandibular) ligament [illegible] is attached to the mandibular spine.

Step 5. [illegible] the inferior dental (alveolar) nerve. Bring it into the wound [illegible]. Keep the field dry. (Plug with adrenalin [illegible].) Remember that the nerve lies in front of the inferior dental vessels. Avoid injuring these.

Step 6. [illegible] the nerve. The wound is permitted to heal by granulation.

[illegible] frequently recurs after even the most extensive [illegible] of the nerve trunk [illegible]. [illegible] and Spiller have shown that marked degeneration is present in the Gasserian ganglion. When [illegible] or even neurectomy is [illegible] to be followed by relief, the Gasserian ganglion should be removed.

REMOVAL OF THE GASSERIAN GANGLION

Anatomic Considerations. The Gasserian ganglion (ganglion semilunare) [illegible] in [illegible] slight depression on the apex of the petrous portion of the temporal bone. In shape it is [illegible] crescent with its convexity forward, measuring from [illegible] cm. in width and about [illegible] cm. in length. The surface of the ganglion presents an irregular [illegible] appearance. From the anterior [illegible] border of the ganglion [illegible] the ophthalmic and maxillary nerves and the sensory portion of the mandibular nerve while its [illegible] posterior margin is continued into the sensory root of the fifth nerve. The ganglion lies in Meckel's space (cavum Meckeli) [illegible] produced by [illegible] of the dura mater and comes in relation internally with the cavernous sinus and the internal carotid artery. [illegible] the motor root of the trifacial and the great superficial petrosal nerve. In structure it resembles [illegible] spinal ganglion, being composed of the characteristically [illegible] from whose single processes [illegible] the peripherally directed dendrites and the centrally [illegible]. In addition to the three large trunks given off from the anterior margin, the branches of the Gasserian ganglion include some fine meningeal filaments which arise from the posterior end of the ganglion and are distributed to the adjacent dura mater.

HARTLEY-KRAUSE OPERATION

Shave the patient's head and prepare it as outlined under operations on the brain. The face and external auditory meatus are also cleaned and [illegible] thoroughly. Pack the external auditory meatus with iodoform gauze. (Fig. [illegible], p. [illegible].)

Step [illegible]. Make [illegible] curved incision beginning on the zygoma immediately in front of the tragus. The convexity of the incision is directed upward. It ends on the zygoma at [illegible] point about one and one-half inches in front of its starting point (Fig. [illegible]). The flap thus outlined is about [illegible] inches in height, [illegible] inches wide at its broadest part, and [illegible] about [illegible] inches wide. [illegible] With chisel and mallet, [illegible] cutting edge or an electric saw or preferably with [illegible] divide the skull along lines corresponding to the wound. Turn down the flap consisting of the skin, temporal muscle, pericranium [illegible] to the bone and the bone. [illegible] the bridge of bone opposite the pedicle. The [illegible] act as a hinge. The line of fracture at which the bone-flap is reflected is opposite the zygoma, therefore at [illegible] higher level than the base of the skull. With [illegible] forceps bite away the bone immediately below the opening in the skull until the true floor of the middle fossa of the skull is reached. This removal of bone after the bone flap has been reflected is an extremely important step in the operation.

Fig. [illegible]. Hartley-Krause operation. Incision for the removal of the Gasserian ganglion.

With the finger quickly separate the dura from the base of the skull until the foramen spinosum and middle meningeal artery are reached (Fig. [illegible]). Fedor Krause recommends quick work with the finger, this being without danger and producing less venous bleeding than slow separation with [illegible] blunt [illegible]. However this step is followed by brisk venous bleeding, control it by gauze [illegible]. When the foramen spinosum is reached, gently lift up the brain, covered by the dura mater, with [illegible] spatula bent at a right angle.

[illegible] made the important observation that when the patient's head is hanging downwards and somewhat to the side, the brain recedes, the [illegible] cavity thus becomes wider and it [illegible] no longer necessary to retract the brain with [illegible] spatula. On the other hand, with the head in this position, the venous bleeding is more profuse. Retract the brain sufficiently to afford good exposure of the deep structures.

Step 3. The middle meningeal artery is ligated doubly and divided. The artery often runs in [illegible] deep groove or even in [illegible] canal in the skull and may be torn when it [illegible] while the bone is being removed. In such event, control the bleeding by packing the foramen with [illegible] thin strip of gauze or with Horsley's wax. Separate the dura mater farther from the bone with [illegible] blunt instrument in the direction of the ganglion. Bleeding at this step is usually brisk

but packing with gauze against the bone for a few seconds will usually control it.

Step 4. When the ganglion is reached, recall that its upper surface is often firmly adherent to the dura. Separate it by blunt dissection. Should the dura be opened while separating the ganglion, cerebrospinal fluid will issue but this is of no importance. Seize the posterior portion of the ganglion [illegible] with the jaws of [illegible] hemostat. Identify and isolate the second and third divisions of the fifth nerve, divide them with [illegible] at the foramen rotundum and ovale respectively. Do not attempt to isolate the first division of the nerve because it is closely united with the cavernous

Fig. [illegible]. Extradural exposure of the Gasserian ganglion.

sinus which may be injured. Bleeding accompanying the division of the second and third divisions of the nerve [illegible] easily stopped by pressure or by [illegible] blunt instrument into their foramina. With the forceps previously applied to the ganglion, make traction along the axis of the nerve. This pulls the ganglion out and with it [illegible] longer or shorter portion of its root is delivered.

Step 5. Replace the brain. Return the temporal osteoplastic flap into place. Provide drainage, if deemed advisable. Drain.

Step 6. For several weeks after the operation, danger threatens the eye of the side involved. Being rendered anesthetic it is subject to injury (dust, contacts, etc.). It should therefore be kept protected and clean by means of boracic acid lotion. The eyelid is closed by one or two sutures so placed that while the eye is closed the boracic solution may still be applied. Remove the sutures from the eyelids after two or three days. Protect the [illegible] by [illegible] watchglass-shield held in place by adhesive plaster.

Comments. Should threatening hemorrhage occur during the operation, suspend the operation. Pack the wound with gauze, dress and keep the patient in bed for a few days. Resume the operation when the condition of the patient warrants it. Should the cavernous sinus be injured during removal of the ganglion, the gush of blood can always be easily checked by gauze pressure because the blood-pressure in the sinus is very low.

ABBÉ OPERATION

In order to avoid the dangers of hemorrhage, shock and prolonged operation, Abbé has given up attempts formally to resect the Gasserian ganglion. He performs an intracranial neurotomy or preferably neurectomy and then prevents reunion of the divided nerves by interposing a layer of thin rubber tissue. To lessen hemorrhage from the middle meningeal artery Abbé ligates the external carotid artery just above the thyroid, although Cushing and others see no benefit from ligating the external carotid artery because most bleeding is venous.

Step 1. Ligate the external carotid (optional).

Step 2. Make a straight incision in the temporal fossa above the zygoma, split the temporal muscle, stripping it widely from the bone, and enter the skull by a small trephine opening, rapidly enlarged by rongeurs to 1½ inches in diameter.

Step 3. Expose the second and third branches from the Gasserian ganglion to the foramina. Seize each at the foramen by a narrow clamp, cut it, and resect a half-inch, or tear it from the ganglion; push the dura well back beyond the foramina.

Step 4. Arrest bleeding by pressure and spread over the bone a piece of sterile rubber tissue (sterilized in bichloride solution and washed in saline) more than enough to cover both foramina, one inch wide by an inch and a half in length. This must be pressed upon the bone by a strip of gauze packed over it for a couple of minutes.

Step 5. When the gauze is removed, the rubber tissue lies in close contact with the skull and the dura is allowed to settle down in its place upon it. The wound is then closed by a few fine catgut sutures and drained for a day at its lower angle.

G. R. Fowler recommends Crile's plan of temporary occlusion of both common carotids as a useful procedure. Abbé's operation gives excellent results and seems preferable in every way to the more formidable excision of the ganglion.

Exposure of the Gasserian Ganglion and the Three Divisions of Fifth Nerve by the Direct Infra-Arterial Route (Cushing's Method)

Step 1. The head is shaved and the patient laid on one side and supported by a pillow. The surgeon stands at the side of the head either in front of or behind the patient and his assistant opposite. The zygomatic arch is outlined. A horseshoe-shaped incision is made, the ends of the two limbs extending to the outer and inner ends of the zygomatic arch about 4 cm. apart and the upper part of the convexity reaching about 5 cm. above the zygoma. The temporal vessels are secured.

Step 2. A second horseshoe incision, somewhat smaller than the first, is made through the temporal fascia. Its base passes through the periosteum along

the outer aspect of the zygoma, mesially. With the exception of the periosteum along the attachment of the masseter muscle, the zygoma is freed of its periosteum through this incision. With a Gigli saw divide the zygomatic arch at its inner and outer ends after first drilling on each side of the saw-cut as a preparation for future ligatures.

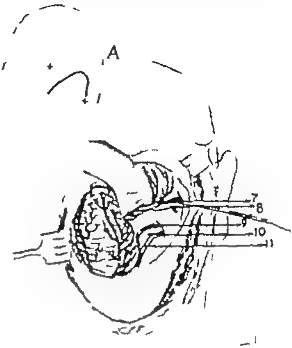


Fig. 277. Intracranial section of auditory nerve for Ménière's disease. Complete division of the eighth nerve [illegible] to the underlying facial nerve. A, Skin incision for [illegible] of the [illegible] nerves. (Dandy.)

Step 3. Divide the temporal muscle down to the bone along the line of the legs and convexity of the preceding horseshoe incision and turn the flap of soft parts, with zygoma attached, downward, retracting it in order to expose the zygomatic crest (infra-temporal ridge), the lower part of the temporal fossa and the starting point of the pterygomaxillary fossa.

Step 4. Make an incision with a 3 cm. trephine in the prominent portion of the sphenoid wing exposing the dura in the middle fossa of the base of the skull at a point to the outer side of and about midway between the foramen ovale and rotundum—near these foramina and below and to the outer side, the middle meningeal artery emerges from the foramen spinosum.

Step 5. After carefully detaching the dura from the bony wall of the middle fossa, the Gasserian ganglion and its three branches are exposed. Meckel's cavity, which should be recognized and opened before reaching the Gasserian ganglion and its branches, is incised along its outer aspect between the second and third nerves where they enter their foramina. The upper part of the roof of Meckel's space is gently opened by blunt dissection exposing the ganglion and its second and third branches upon the floor of this space. The floor is now detached from these nerves by blunt dissection until the ganglion is lifted from it. The dura is dissected on the inner side toward the first division where it contacts the cavernous sinus and sixth nerve. With blunt hooks, the second and third divisions are stretched and divided close to their foramina. With forceps, the body of the ganglion with the origins of the first, second and third divisions is torn out.

Step 6. Avoid wounding the middle meningeal artery. Temporary packing controls hemorrhage from the cavernous sinus, small arteries and veins. The wound is closed entirely if continuous packing is unnecessary; the structures, including the zygoma, are sutured back into normal position. The eye is relieved from all pressure by a rubber protector.

Comment. Serious hemorrhage is avoided by approaching the ganglion from below the middle meningeal artery. The necessity of bone-covering is less here than in operations which reach the ganglion through the temporal fossa because of the small size and protected locality of the opening through the skull. The ganglion should not be removed until it has been freed from the envelope of reflected dura which should be done first, from above thus lessening the danger from hemorrhage. Oftentimes the sixth nerve is injured when the ophthalmic division of the nerve is freed; on account of its intimate relation, the sympathetic nerve is always torn, but these accidents are rarely serious. Sometimes the zygoma is not sutured into position but is permitted to settle into its permanent position on the muscles of mastication atrophy. Ligation of the middle meningeal artery is sometimes necessary.

NEURECTOMY

Acoustic Nerve

This is on occasion resorted to in intractable Ménière's disease. It consists of sectioning the eighth (auditory) nerve. Local or general anesthesia may be resorted to.

Step 1. Make a curved incision (Fig. 277-A) having its convexity upward and situated low over the occiput on the affected side. (Dandy.) Begin the incision laterally at the level of the tip of the mastoid process, curving upward and then medially and downward to the midline to a point on a level with its beginning. The musculocutaneous flap thus obtained is freed from the bone.

Step 2. Make an opening in the occipital bone of about 1½ inches in diameter over the posterior fossa of the skull and just medial to the mastoid bone. This affords the most direct approach to the cerebellopontine angle.

Step 3. Make a dura flap by an incision corresponding to that in the skin. Multiple radiating incisions may, on occasion, be resorted to.

Step 4. Expose the cisterna magna and the lateral cistern, puncturing them with an appropriate needle and evacuate the contents by suction. This affords greater operative field and greatly facilitates retraction of the cerebellum.

Step 5. Retract the cerebellum, gently, medially, exposing the seventh, eighth, ninth, tenth and eleventh basal nerves. The seventh (facial) nerve is practically covered by the eighth (acoustic) and cannot be seen until the latter is lifted from it by a small hook. The acoustic nerve is lifted gently upward and backward well away from the underlying facial nerve and then the acoustic is divided using a fine-pointed knife (Fig. 277 B). Sometimes, when deafness is not complete, an attempt is made to cut only the vestibular part of the nerve leaving the auditory portion intact.

Step 6. The dura may be closed or left open. It is never closed if radical measures have been made. The muscle, fascia and skin are closed in layers. No drains are used.

Comment. Anomalies of the blood-vessels may add difficulties to the operation. Exposure of the eighth nerve may be hindered by an artery from the cerebellum which may cross it and even supply it with a twig. Occasionally a branch of the auditory artery may lie within the nerve and severing it will result in annoying hemorrhage. Temporary, and even permanent, facial paralysis may ensue. This may result from trauma to the seventh nerve during manipulations or from pressure by the swollen stump of the eighth nerve. Vertigo is, as a rule, abolished by the operation. Temporary unsteadiness or dizziness on suddenly moving the head, however, may be present following surgery but this gradually disappears. Tinnitus is not always completely relieved but it is usually favorably modified.

Neurectomy of the Glossopharyngeal Nerve

Division of this nerve is performed for glossopharyngeal neuralgia. Intracranial section of the nerve is the procedure of choice because here separation of the nerve is impossible and because possible injury to the vagus nerve is obviated. For these reasons the extradural route is not used.

Step 1. The nerve is exposed by the same steps as for exposure of the eighth nerve.

Step 2. As the cerebellum is gently retracted medially the ninth, tenth and eleventh nerves can be seen converging toward the jugular foramen. The most anterior of the three is the ninth nerve. It is about 1 mm. in diameter and leaves the skull through a separate canal. It is caught up by means of a small hook and divided, using a fine pointed knife or scissors.

Step 3. The wound is closed in layers with the exception of the dura which is usually replaced and left alone.

CHAPTER II

SURGERY OF THE SINUSES AND TONSILS

OPERATIONS ON THE SINUSES

FRONTAL SINUS

External Approach

There are enormous [illegible] in the size and shape of the frontal sinuses, hence no operation should be undertaken [illegible] roentgenographic study. There are two methods of approach to the frontal sinuses: intranasal and external. The intranasal approach is more dangerous than the external [illegible] limited space [illegible] of operative field [illegible] the only advantage of operating intranasally is that the [illegible]

[illegible]

the surface approach is avoided. Most modern surgeons abandoned the blind intranasal approach to the frontal sinus in favor of the external approach.

THE KILLIAN OPERATION

This is indicated in frontal sinus suppurations especially if complicated by disease of the ethmoid. It exposes and drains the frontal sinus by the external route. Local anesthesia. (Fig. [illegible])

Step 1. Make an incision down to the bone extending along the whole length of the eyebrow just above the orbital margin. Continue the incision at its inner end down the middle of the nasal process of the superior maxilla (Fig. [illegible]).

Step 2. Make two incisions in the periosteum (Fig. [illegible]). The upper one is [illegible] above and parallel with the supraorbital margin and ends near the glabella; the lower one corresponds with the skin incision running along the supraorbital margin. [illegible]

Step 3. [illegible] through the bone [illegible] and parallel to the margin of the orbit [illegible] forceps remove the [illegible] wall of the frontal sinus [illegible] (Fig. [illegible])

Step 4. Clean out the sinus and remove [illegible] mucous membrane thoroughly.

Step 5. [illegible] of operation [illegible] in the floor of the sinus [illegible] to the supraorbital arch. After the opening is made remove the rest of the floor with bone forceps.

Step 6. Resect the frontal process of the superior maxilla and the rest of the floor of the sinus.

Step 7. Remove the anterior and middle ethmoidal cells and the respective parts of the [illegible] because these structures are usually also affected.

Step 8. [illegible] the wound with salt solution. Close the wound. [illegible] rubber tube passing from the temporal end of the incision down through the external [illegible] of the nose.

[illegible]

MAXILLARY SINUS

Empyema of the Antrum of Highmore (Maxillary Sinus)

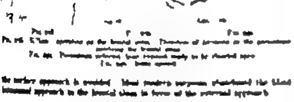
Maxillary antrum suppurations usually result from propagated infection from the sockets of decayed teeth in the upper jaw or from an intranasal infection (Fig. [illegible]). If dental, such an abscess may be temporarily drained by the extraction of one of the premolar teeth or if nasal in source by drainage tube introduced from the nose into the sinus.

NASAL APPROACH TO THE MAXILLARY SINUS

Step 1. Local anesthesia suffices (Fig. [illegible]). Puncture the antronasal wall through the interior of the nose with a trocar. The point of the trocar (Fig.

[illegible]) should be turned outward, reaching the nasal wall of the antrum under the inferior turbinate bone.

Step 2. [illegible] the instrument enters the antrum. [illegible] the pus to escape and wash out (irrigate) the antrum. If the opening is not sufficient to allow free drainage [illegible]



A B C

[illegible]

[illegible] part of the inferior turbinate may have to be removed to facilitate free drainage.

[illegible] operation consists of making a rather large circular opening in the naso-antral wall by means of the [illegible]. The steps of the [illegible] operation are as follows:

[illegible]

Step 1. The mucous membrane covering the naso-antral wall and the inferior turbinate bone is completely anesthetized by local application of cocaine.

Step 2. The anterior part of the inferior turbinate is now removed with curved scissors. (Figs. [illegible])

Step 3. The naso-antral wall [illegible] punctured at [illegible] with a perforator.

Step 4. The point of the instrument is introduced into the puncture, and an oval opening is made. The size of the aperture can be regulated by the surgeon and should be large enough to allow the removal of granulations which have tendency to close the aperture.

In chronic cases more radical procedures are called for.

[illegible] OPERATION

Step 1. The general anesthesia. Pack the cheek and mouth with gauze. Raise the upper lip and make an incision through the mucous membrane about [illegible] cm. below the gingivo-labial fold (Fig. [illegible]). Cut down to the bone. Reflect the mucoperiosteum upward. Expose the canine fossa.

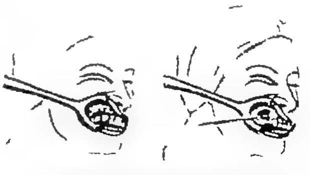


Fig. [illegible] Fig. [illegible]

Fig. [illegible]. The Caldwell-Luc [illegible] upon the maxillary sinus.

Fig. [illegible]. Caldwell-Luc [illegible] on the maxillary sinus. The nasal wall of the maxillary sinus [illegible] below the level of the attachment of the inferior turbinated bone.

Step 2. The bone forming the front wall of the upper jaw is then opened up by means of hammer and chisel, gouge or small trephine and freely removed by enlarging the opening with rongeurs to the extent of about half an inch. A counter opening is made from the inner wall of the antrum into the nose, making a hole into the latter cavity large enough to allow the passage of the tip of the finger (Fig. [illegible]). Free bleeding usually occurs immediately after opening the sinus. It is promptly controlled by adrenalin packing.

Step 3. The cavity is cleaned of pathologic products (curetted) and is tightly packed with gauze; the end of the gauze pack is brought out through the nostril and the cheek is allowed to fall into position without any sutures. The gauze is allowed to remain in place for one or two days and is then loosened gradually by irrigation with peroxide of hydrogen until the discharge ceases.

Generally these operations are made use of for suppurations in the antrum of Highmore; these vary according to the degree of suppuration.

1. Tapping the antrum through the alveolar process.

2. The radical operation, as outlined above, in which the antrum is exposed through the canine fossa.

3. Drainage through the nose, here a portion of the naso-antral wall and inferior turbinate are taken away.

Intranasal Operations on the Frontal, Ethmoid and Sphenoid Sinuses

Anatomic Considerations (Fig. 48). The ethmoid cells consist of numerous thin walled cellular cavities distributed within the ethmoid bone on either side, placed between part of the orbit which forms its outer wall and part of the nasal fossa which forms its inner wall. These cells are developed when the baby

Fig. 48. Nasal septum viewed from left side; mucous membrane has been partially removed. (Pernkopf.)

[illegible] is five years of age. They are surrounded, superiorly, by joining with similar cellular cavities which bound the ethmoidal notch of the frontal; posteriorly, by joining with similar cellular cavities which consist of the sphenoidal turbinated bones and the orbital processes of the palate bones; anteriorly, by joining with the lacrimal bones and the nasal processes of the superior maxillae; below, by joining with the superior maxillae.

Descriptions of the ethmoidal cells vary; they are sometimes said to consist of three groups, walled off from each other, viz., anterior, middle and posterior; at other times they are said to consist of an anterior and posterior group. Independent openings or [illegible] common opening connect the anterior and middle cells with the fore-part of the middle meatus of the nose. The frontal sinus communicates through the anterior ethmoidal cells by way of the common infundibulum ethmoidale; when the communication is by a single opening, with the middle meatus. The posterior part of the superior meatus communicates with the posterior ethmoidal cells or sometimes with the sphenoidal sinus. On a few occasions the ethmoidal sinuses communicate with the maxillary antrum.

Remove the anterior end of the middle turbinate.

Step 1. With a long handled curet, enter the agger nasi cell which is situated just anterior to the anterior attachment of the middle turbinate. With a backward-downward motion, remove all of the ethmoid cells as far back

as the sphenoid, care being taken to remain lateral to the middle turbinate to avoid entering the cribriform plate. (Figs. 49-50.)

Step 2. The middle turbinate will then be hanging loosely in the nose and can be removed with a snare. The remnants of the ethmoid cells and mucosa are gently curetted until the orbital plate is felt to be perfectly smooth.

Step 3. The curet is now directed against the ascending process and the anterior cells removed. This gives an opening to the naso-frontal duct and a probe can be passed into the frontal sinus. With a Ostmann's rasp, the naso-frontal duct can be enlarged. Care is taken to rasp forward only so as to prevent stenosis of the duct and intracranial complications.

Step 4. When the ethmoid is completely exenterated, the front wall of the sphenoid can be easily seen. (Fig. 51.) The ostium is now enlarged with a curet and the entire anterior wall taken down with a sphenoid punch. (Figs. 50, 52.) Some operators prefer a burr for this procedure. Care must be taken to avoid injury of the sphenopalatine artery which runs along the lower border of the anterior wall. Anomalous internal carotid arteries are occasionally found traversing the sphenoid cavity.

Step 5. When this operation is completed, it is best left unpacked, but in the presence of moderate bleeding, a light vaseline gauze pack is inserted; this should be removed in 24 hours.

External Operations on the Ethmoid and Sphenoid Sinuses

Step 1. This operation can be done under general or local anesthesia. If general anesthesia is used a tampon is inserted into the nasopharynx to prevent the blood and debris from entering the trachea and bronchi.

If local anesthesia is desired, sufficient premedication is given. The eyelids are closed by a temporary suture of horsehair. One per cent novocaine solution in a syringe carrying a long needle is used. This is inserted through the upper lid and follows the superior medial bony border of the orbit for about 1½ inches. Injection is slowly made on the removal of the needle; the purpose is to infiltrate the anterior and posterior ethmoid nerves. Subcutaneous injection is made along the site of the incision described below.

Step 2. Make a curved incision from the supra-orbital notch about ½ of an inch medial to the inner canthus of the eye, and down to the lower edge of the nasal bone. This is carried down to the periosteum.

Step 3. The periosteum is divided and reflected laterally and medially by means of a periosteal elevator. The lacrimal sac is reflected with the periosteum, being turned laterally out of its bed in the lacrimal groove. The periosteum is elevated from the orbital plate of the ethmoid for about 1 inch. Here the posterior ethmoidal artery can be seen. This is ligated by means of the Yankauer instruments.

Step 4. Freer-Smith self-retaining retractor is inserted to give adequate exposure.

Step 5. The ethmoidal cavity is entered through the lacrimal groove; the bone is thin here and can be entered with a curet. This opening is enlarged anteriorly and superiorly; the ascending process of the superior maxilla

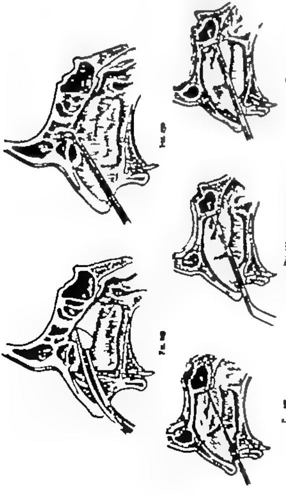


Fig. 49. Fig. 50. Fig. 51. Fig. 52. [illegible]

being removed with a Kerrison rongeur. This will give a good external approach to the ethmoid labyrinth.

Step 6. The anterior third of the middle turbinate is removed with scissors and snare, through the nose. A Grünwald punch is introduced through the nose, and, by direct vision through the external opening, the ethmoid cells are removed. Care must be taken to remain between the attachment of the middle turbinate and the orbital plate, so as not to enter the cranial cavity in the region of the cribriform plate. The cells are removed until the orbital plate of the ethmoid and the roof of the ethmoid are perfectly clean. Anteriorly the removal of the ethmoid cells exposes the opening of the naso-frontal duct and the frontal sinus can be entered with a probe.

Step 7. When the ethmoid is exenterated, the remaining portion of the middle turbinate is removed. This exposes the front wall of the sphenoid. The ostium is located and enlarged and the front wall is taken down.

Step 8. A small rubber tube is now passed from the nose out through the wound, covered with vaseline and covered with a Thiersch graft (skin side out) to project above and below the opening in the bone. This forms a drainage duct and at the same time the graft adheres to the underlying muscle and periorbita and prevents these structures becoming adherent to the bone. The skin is closed with silk and an eye-pad and a firm bandage applied to the eye. Beginning with the fifth day suction is removed by gentle suction. No intranasal dressing is used.

OPERATIONS ON THE TONSILS

TONSILLECTOMY

Anatomic Considerations. In theory the faucial tonsils are two oval-shaped collections of adenoid tissue located between the faucial pillars on either side of the oropharynx. They are from 20-25 mm. long, 15 mm. wide and 10 mm. thick. In children the tonsils generally appear as projecting, globular masses; if they project to any degree beyond the faucial pillars, they are enlarged. After middle life, the presence is usually negligible. The size of the deep surface is not indicated by the size of the free surface. They are enveloped in a capsule which is interrupted by a [illegible] of the free surface. The layer from the [illegible] layer of muscle fibers on both the deep and free surfaces. The deep layer begins at the superior constrictor and extends to the tongue. The free surface contains numerous crypts varying in depth. The supratonsillar fossa is a small opening above the tonsil, in front of which frequently appear numerous pits surrounded by adenoid tissue, located under the anterior pillar behind and forming a pocket under a fold referred to as the plica triangularis.

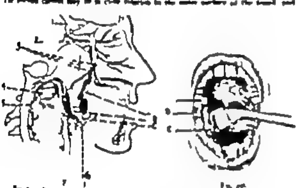
Blood Supply. (Fig. 53.) The tonsils obtain their blood supply from different sources, branches from the ascending pharyngeal and facial arteries enter it on the lower while branches from the descending palatine and lingual arteries enter it under the mucous membrane. The veins form a venous plexus connecting with those of the pharynx. The lymphatics connect with those of the dorsum of the tongue and the nodes found close to the angle of the jaw.

Nerves. The fifth and glosso-pharyngeal nerves furnish the nerve supply for the tonsils.

The pharyngeal tonsil is frequently referred to as the third tonsil. It is located in the posterosuperior wall of the pharynx and reaches its greatest size about the age of twelve, gradually diminishing in size after that. It [illegible] on [illegible] [illegible] Since the pharyngeal tonsil consists of many lobes, the openings frequently enter several [illegible] central depression resulting in numerous pockets. The

[illegible]

[illegible]



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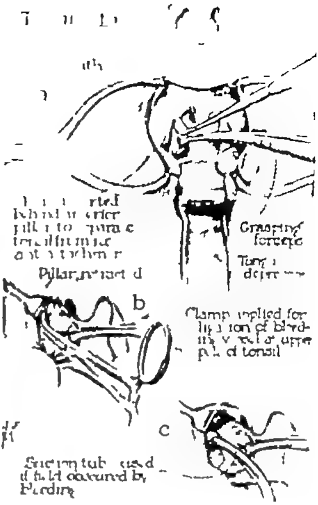


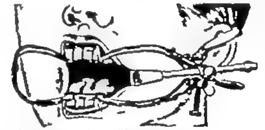
Grasping forceps
b
c

[illegible]

d
e
f
g
Wire loop of snare
Fossa packed with gauze. Pack left in place while other tonsil is being removed

[illegible]

[illegible]



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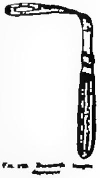
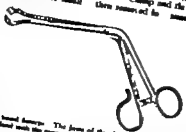


[illegible]

Step 3. Complete the removal of the tonsil by the snare (Fig [illegible]). Make sure that the loop of the snare is well placed. Clamp and tie bleeding points, if necessary. The opposite tonsil [illegible] then removed [illegible] similar manner.



[illegible] MacKenzie tonsil forceps. The jaws of this forceps are shaped so they will firmly take hold of the gland with the minimum amount of damage to the surrounding tissue.

There are many methods of dissecting the tonsils but the principles underlying the procedure are the same in all, [illegible] incision of the plica triangularis and blunt or sharp dissection of the tonsil.

The Sluder Guillotine Technic

Step 1. Place the patient in the upright position. Local anesthesia. Introduce the Sluder guillotine (Fig [illegible]) through the left angle of the mouth until the

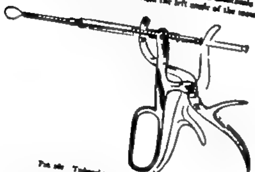


Fig [illegible] "Tydings" tonsil snare [illegible] model.

far part touches the lower and back part of the tonsil. The instrument is held firmly against the structures which are displaced anteriorly and superiorly for about [illegible] cm from the tonsil.

Step 2. The tonsil is pulled forward until the far border of the fenestrum of the instrument lies nearly upon the summit of the [illegible]. The handle of the guillotine is then lowered sufficiently to bring the upper part of the border of the fenestrum into close contact [illegible] the lower part of the tonsil.

Step 3. The tonsil is pushed through the window of the guillotine by pressure with the finger from the surface overlying the tonsillar area, the blade of the instrument being slightly pressed against the anterior part of the tonsil to steady it while the rest of the tonsil is pushed through the ring. Advance the blade of the guillotine by thumb pressure until the tonsil passes through the fenestrum; the blade is further advanced until only the thin, soft mucous membrane of the anterior pillar and posterior pillar intervenes between the finger tip and the far border of the ring of the instrument.

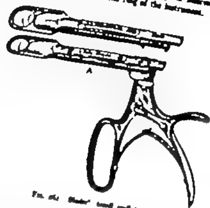


Fig [illegible] Sluder tonsil guillotine.

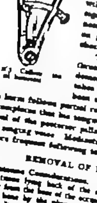
Step 4. Push the blade of the instrument firmly home, thus completely severing the tonsillar connections and bringing away the tonsil in its intact capsule.

Judging from the literature, complete success with the Sluder operation is attained in only about [illegible] per cent of the cases. The [illegible] tonsils, even although well buried, are easily removed by this method, but the flat, or very fibrous ones are difficult to dislodge, especially if the pillars of the fauces are infiltrated.

Dangers and Complications. Because many thousand pairs of tonsils are successfully removed daily in the civilized world, the operation, nevertheless, carries with it [illegible] certain degree of risk. It is not [illegible] minor operation. No operation is [illegible] minor operation if major catastrophe, though remote, may result. The removal of tonsils in physician's offices and out patient clinics is to be condemned. Tonsillectomies, like other operations, require skill and experience. On more than one occasion have I turned my head when [illegible] general surgeon after completing (?) the operation removed much around the tonsil and left most of the tonsil behind. I have heard much of tonsils that "grow again" and I often wondered if so-called recurrences are really not tonsils incompletely enucleated.

Besides hemorrhage, shock and aspiration pneumonia, there remains the possibility of injury to the uvula, the pillars and the tongue. If, at the beginning, the right cleavage plane is found and is followed with care, there usually should be no difficulty except in "submerged tonsils" and in cases with much inflammatory infiltration.

The most dangerous complication of tonsillectomy is infection. The cavity remaining after the operation heals by granulation. Oral sepsis is responsible for infection to [illegible] greater or lesser extent. Fortunately the drainage here is free and, as [illegible] rule, the reaction following the operation is slight. The [illegible] tonsil commonly but suppuration is rare. Nevertheless, general sepsis, while rare, is [illegible] possibility.



[illegible] Collins [illegible] of [illegible]

Hemorrhage immediate or delayed, is the most common complication. It is usually venous in type but may be arterial. Prompt recognition of the source of bleeding is essential. Treatment consists of removal of clots, compression by special instruments (Fig [illegible]), or clamping and ligating the bleeding vessel or suturing together of the anterior and posterior pillars or suturing them over [illegible] plug of gauze. It cannot be too strongly emphasized that [illegible] child will bleed at times even to death without visible signs of hemorrhage (Bryant). Constant watchfulness is the only safeguard. Shock must be treated on general principles after the bleeding has been checked.

The immediate results of tonsillectomy are sore throat, pain behind the ears and dysphagia. A pseudomembrane forms in the tonsil bed and healing takes place in about [illegible] fortnight. If the pillars have been injured, healing is considerably delayed. Not much harm follows partial removal of the anterior pillar—the patient usually complains that his tongue is tied to the roof of his mouth. Injury or removal of the posterior pillar results in more or less serious impairment of the singing voice. Medicolegal complications and aspiration pneumonia [illegible] more frequent following tonsillectomies than is reported.

REMOVAL OF PHARYNGEAL ADENOIDS

Anatomic Considerations. ([illegible]) The pharyngeal tonsil [illegible] mass of adenoid tissue lying back of the soft palate, between the eustachian tubes, and extending from the base of the occiput to the lower edge of the [illegible] being separated from the bone by the pharyngeal aponeurosis and the superior constrictor of the pharynx. It varies greatly in shape, from the flat and [illegible] to the rounded and soft protruding mass. Smaller but similar patches of lymphoid tissue are to be found scattered all over the pharynx and even the posterior surface of the posterior pillars of the fauces, from which [illegible] may readily be seen that the complete removal of adenoid tissue from the throat [illegible] an impossibility. The points of surgical [illegible]

mark are the posterior edge of the vomer above, the internal openings of the Eustachian tubes on either side, and the uvula in front. (Fig [illegible])

Step [illegible] Put the patient in the Rose position (Fig [illegible]). Extend the head moderately. Insert [illegible] mouth gag separating the jaws widely. Introduce the left forefinger into the nasopharynx; hook the uvula out of the way.

Fig [illegible] Lateral view of the faucial tonsil and pharyngeal region. (Davis, Applied Anatomy)

Step 2. Insert the adenoid curet carefully until you feel the vomer; depress the handle of the instrument as far as possible. With one sweep of the instrument, curet downward, thus removing briskly the entire mass of adenoids. A dull curet or too light pressure will not accomplish the object. Experience and judgment must be the guides. Too great pressure will cause injury to the pharyngeal aponeurosis or even to the vertebrae.

Fig [illegible] Anatomic points of interest in removal of adenoids. Position of adenoid curet [illegible] adenoids.

Step [illegible] Repeat the same maneuver on either side of the median line pressing the curet well over into the lateral sulci. The forefinger is then passed well up into the posterior nares on either side and remnants of adenoid tissue searched for which should also be removed with the curet. Clear the space with dry sponges.

Comment. The principal danger of the operation is aspiration pneumonia. T[illegible] avoid this, operate quickly and turn the child promptly on its face. Clumsy work jeopardizes the uvula and may injure the vomer, the vertebrae or the Eustachian tubes. Use judgment in avoiding the nares.

advanced cases) the best interests of the patient are served by palliat[illegible] operation.

Inoperable cases are best left alone. The degree of involvement should be gauged before operation is undertaken. If after beginning the operation the surgeon finds that fixation is considerable, it is wiser to abandon the operation

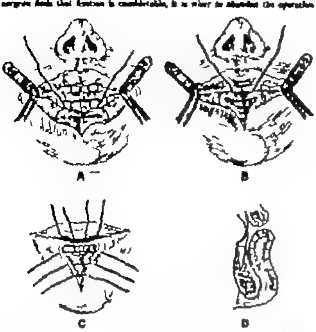


FIG. [illegible] A. V-shaped resection of lip. [illegible] B. [illegible] C. Diagram showing the position of the [illegible] D. [illegible]

and close the wound. A [illegible] may thus be averted. In such cases the benefits of radium (deep x-ray radium) should be accorded the patient.

Comments. The sooner [illegible] correct diagnosis is made and the malignancy removed the better the prognosis. A thorough knowledge of the anatomy of the parts is essential. Opinions as to results of forms of treatment differ. According to Waring, radium is of no value. He considers [illegible] more effective. [illegible] is partial to electrocoagulation. Kennedy believes radium to be the sovereign remedy for carcinoma of the lip. Further pro-

[illegible] x-rays; he favors radium for inoperable cases. I am inclined to disagree with Waring. The appended photographs tell their own story (Figs. [illegible]).

Dogmatism is obviously dangerous. Careful selection of cases and the use of a combination of properly indicated and selected methods will give the best results.

[illegible] in discussing carcinoma of the lip concludes as follows:

"1. About [illegible] per cent of epidermoid carcinomas involving not more than one-half of the lower lip will not be associated with regional metastasis. The indiscriminate use of radical surgical intervention and irradiation is neither necessary nor to the best interest of these patients.

FIG. [illegible] [illegible] of lip.

"2. A small percentage of carcinomas of the lip are [illegible] and metastasize early. In these cases there are not more than [illegible] per cent of cases. It is the impression that these lesions arise from the buccal mucous membrane and bear the characteristics of buccal carcinoma else-

FIG. [illegible] FIG. [illegible]

FIG. [illegible] Carcinoma of the lip [illegible] submaxillary lymph nodes [illegible]

FIG. [illegible] Same patient as [illegible] April [illegible] after [illegible]

where, while the relative benign, [illegible] cancer of the lip bears the characteristics of epidermoid carcinoma of the skin in general."

Arch. of Surg. [illegible]

The operation consists of three phases, viz. removal of the lymph nodes, removal of the tumor and restoration of the contour of the lip. It is best to remove the lymph nodes first, then the tumor. The primary removal of the lip and restoration of its contour often lulls the patient to [illegible] sense of false security. He feels that no second procedure is needed and refuses further intervention. This often leads to disastrous consequences.

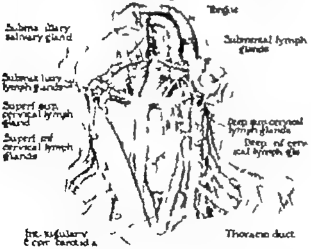


FIG. [illegible] Lymph vessels and nodes of the tongue, submental, superficial and deep cervical regions.

In advanced cases all lymph nodes as well as the submaxillary salivary glands should be removed.

Removal of Lymph Nodes of the Neck

A thorough knowledge of the position of the lymph nodes and their topographic relationship is of utmost importance (Fig. [illegible]). For convenience the lymph structures are divided into three main groups:

1. The superficial cervical nodes
2. The deep superior groups
3. The deep inferior groups

Anatomic Considerations. The superficial cervical lymph nodes are rather small and inconstant and may be divided into three sub-groups: A. The external nodes, situated along the external jugular vein, receive afferents from the

[illegible] deep cervical nodes. [illegible] B. The superior deep cervical nodes [illegible] C. The inferior deep cervical nodes [illegible] the left side into the thoracic duct. Both the right and the left trunk, however, frequently open directly into the subclavian vein.

Note. In applying to clinical practice the anatomical connections of these and other lymph nodes [illegible] should be remembered that as disease the lymphatic vessels may become obstructed and the lymphatic flow thereby reversed. [illegible] separated groups are thus liable to be involved and an enlargement of the nodes on the side opposite to that of the lesion are rather frequent.

Step [illegible] The incision must be so planned as to afford [illegible] (Fig. [illegible]). It follows the line of the sternomastoid muscle and [illegible] forward to the chin. [illegible] Free the skin from its underlying surfaces up to and slightly above the border of the mandible. The whole outer surface of the parts to be removed [illegible] now exposed to view.

Step [illegible] Remove the contents of the submaxillary triangle (submaxillary and submental nodes, areolar tissue, fat and nodes). Begin the dissection from below at [illegible] considerable distance from the enlarged nodes. Clear the [illegible] Dissect carefully, step by step [illegible] of all connective tissue [illegible] in an upward direction. The mass dissected en bloc is now turned [illegible] ward.

Step 3. Ligate the facial and lingual arteries when encountered. The common facial vein is also ligated. The submaxillary duct [illegible] severed and ligated as near the mouth as possible. [illegible] lymph nodes may be [illegible] between the salivary gland and the jaw being firmly attached to the [illegible] These should be removed, of course, together with the platysma, and if need be, with the periosteum of the mandible.

Step 4. In deep dissection of the neck care must be taken to preserve the hypoglossal, spinal accessory [illegible] hypoglossal, recurrent laryngeal and, in very deep dissections, the vagus nerves. The carotid, the superior and inferior thyroid arteries, and the jugular veins and their branches must be respected. If the surgeon [illegible] working in the left supraclavicular fossa he should avoid the thoracic duct.

Step 5. In more extensive dissections for recurrences appearing in the upper part of the neck, the result of carcinoma of the mouth or originating from

branchial cyst, the [illegible] lymph node bearing area from [illegible] to [illegible] should be removed. In such cases the sternomastoid muscle is [illegible] by [illegible] [illegible]. Both the external and internal jugular [illegible] ligated and divided [illegible] the [illegible] nerve. The [illegible] is carried back and [illegible] from the deep muscles of the neck. The entire dissection is [illegible] from below upward.

Fig. [illegible] Block dissection of the lymph nodes of the neck [illegible] [illegible] [illegible] of the [illegible] [illegible] [illegible] [illegible] between the carotid sheath and the [illegible] [illegible]

Removal of Carcinoma of the Lip

Step [illegible] *The shoulders and head of the patient are elevated, the head is slightly flexed and is made to rest on a firm pillow or [illegible]*

Local or general anesthesia is given. The coronary arteries may be controlled by an assistant by pressure with the fingers and thumb. Aspiration of blood should be avoided. The incisions should be made at least [illegible] inch from the tumor. Bleeding vessels are picked up [illegible] [illegible] hemostats.

By referring to Fig [illegible] a good idea is gained of the principles of the operation. Figure [illegible] depicts the triangular incisions necessary to accomplish the desired result. (Observe particularly that the distance [illegible] plus [illegible] equals the distance [illegible].) The incisions should be carried as shown in the illustration. The size of the triangles depends upon the size of the tumor to be removed.

Step [illegible] Excision of the tumor-bearing area is now done and other triangles are [illegible]. The mucous membrane of each triangle is preserved (Fig [illegible])

Step 3. The sutures are placed in such a manner as to approximate [illegible] and [illegible]. The entire thickness of the lip, excluding the mucous membrane, is

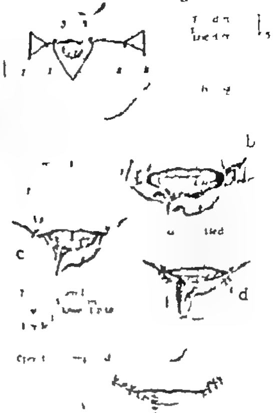


Fig. [illegible] Excision of carcinoma of the lower lip.

[illegible] by the sutures, using [illegible] or [illegible]. The mucous membrane (Fig. [illegible]) is sutured to the skin by interrupted [illegible] in such fashion as to form the vermilion border (d) after being [illegible] into proper shape.

Step 4. Vertical [illegible] of the lower lip is now begun. Interrupted sutures unite the mucous membrane. Three or four such sutures usually suffice depending on the extent of the resection. The skin is next approximated, the first suture being placed at the junction of the skin with the mucous membrane. Care should be taken that the labial commissures be properly [illegible]. [illegible] of the tissues should be avoided. Approximation [illegible] is necessary. Attend to hemostasis. [illegible] [illegible] (Fig. [illegible])

Fig. 476 Fig. 477

Fig. 476. Removal of tumor from the lateral margin of the tongue. Outline of portion to be removed.

Fig. 477. Same operation. The [illegible] [illegible] from the back forward. Sutures placed.

OPERATIONS ON THE TONGUE

REMOVAL OF ANGIOMA OF THE TONGUE

If the size of the tumor is not excessive it may be excised after injecting [illegible] per cent novocaine solution all around it. Bleeding is slight unless the [illegible] are severed. Suture the edges with silk—this also helps to control hemorrhage.

[illegible] methods or radium often yield gratifying results. In larger tumors, use general anesthesia (intratracheal)

Step [illegible] Open the mouth with a gag.

Step 2. Pass a silk loop through the tip of the tongue and pull it forward. An assistant should exert pressure on the tissues immediately outside of the [illegible] wound.

Step 3. Quickly dissect out the growth with scissors followed by [illegible]

Step 4. Suturing with catgut bringing the raw surfaces together and checking hemorrhage. If better approximation of the surface epithelium is desired, additional sutures may be inserted. The mouth wash frequently until healing takes place. (Figs. 476–477.)

ACUTE ABSCESS OF THE TONGUE

Step [illegible] Use general anesthesia through nasal tubes. Make free incisions into the affected substance of the tongue and prevent the inflammatory process

from extending to the cervical planes. The incisions should be made in the long axis of the tongue on each side of the median raphe and, if necessary, should extend to the foramen cecum. Make the incisions deep enough to evacuate the [illegible] [illegible], thus lessening tension.

Step [illegible] Open deep abscesses with blunt artery forceps. Keep the abscess cavity open for a short time by means of an appropriate drain.

RANULA

Ranula (Fig. [illegible]) is a cyst of salivary origin situated in the tissues of the floor of the mouth. They may be either sublingual or submaxillary depending

Fig. 478. Diagrammatic drawing of the evolution of a ranula. A, Toward the [illegible] [illegible] [illegible] toward the submaxillary region.

upon the respective position they occupy. The cysts have a thin wall and are of bluish color and are generally derived from the mucous glands of the mouth or from the [illegible] glands. Occasionally they are derived from either the duct of Wharton or one of the ducts of Rivini. Dermoid cysts in this region are occasionally met with. They are generally derived from the upper part of the thyroglossal duct.

Step 1. Separate the jaws with an appropriate mouth gag. Engage the tongue in proper tongue forceps. Pull [illegible] out of the way.

Step [illegible] When the cyst is small, excise as much of its wall as possible. These cysts can only rarely be dissected out entirely although this should be attempted. The content of the cyst is usually a thick, glairy mucoid fluid. The portions of the cyst wall which cannot be removed should be [illegible]

with the application of a strong solution of silver nitrate or electrocoagulation.

Step 3. Where complete dissection of the cyst is possible the wound in the floor of the mouth should be united with interrupted linen sutures which are removed after about three days.

DERMOID CYSTS

Dermoid cysts in this region are removed by making an incision in the median line from the chin to the hyoid bone. Separate the mylohyoid muscles, divide the other deeper structures until the capsule of the cyst is exposed. Dissect it out bluntly. Close the wound, avoiding dead spaces. Drain, if deemed advisable.

REMOVAL OF FOREIGN BODIES FROM THE TONGUE

When x-ray or palpation confirms the suspicion that a foreign body such as a sharp piece of metal, wood or bone is lodged in the front part of the tongue the mouth is rendered aseptic and a piece of sterile gauze is used to hold the tongue forward.

Step 1. Inject a few drops of 1 per cent novocaine solution over the most sensitive part and make an incision with a scalpel down to the foreign body. Hemorrhage may be controlled by pressing with the fingers on either side of the incision.

Step 2. If possible, the foreign body should be removed in the opposite direction from which it entered the tongue. The incision should be sutured with silk and drainage, provided if the wound is a large one; otherwise, the incision is permitted to heal without suturing. If the foreign body is lodged in the back part of the tongue, general anesthesia may be necessary. Have tracheotomy set ready in case of unexpected emergencies.

TONGUE-TIE

Where the frenum is so short that the tip of the tongue cannot be protruded beyond the lower gum-line (interference with nursing) divide the frenum, remembering while doing so the ranine arteries located beneath the mucous membrane on the under surface of the tongue on each side of the frenum. Immediately under the ranine vessels on the floor of the mouth are the sublingual vessels.

Step 1. In order to avoid these vessels, inject a few drops of 1 per cent novocaine solution into the frenal region, elevate the tip of the tongue and sever the frenal band with a scalpel.

Step 2. If this is not sufficient to bring up the tip of the tongue, enlarge the incision posteriorly exactly in the middle. Control hemorrhage with a ligature of fine catgut carried on a small curved needle and passed immediately under the vessel. Leave the incision open.

An antiseptic mouth wash should be used several times daily.

Comment. Look out for hemophilia. Several fatalities have been reported from this cause. If the infant is able to nurse satisfactorily, postpone the operation until the baby is about 6 months old.

Acquired Tongue-Tie. This usually results from scar tissue formation following infections. The tongue becomes attached to the mucous membrane of

the gums or cheeks. Sever these attachments under novocaine anesthesia. Dissect carefully. Interpose sterile rubber strips between the denuded surfaces until tissue granulation occurs, thus avoiding reunion of the raw surfaces. Maintain oral asepsis.

EXCISION OF THE TONGUE

Removal of the tongue, either in whole or in part, is indicated whenever malignant conditions within the limits of operability are present. These include primary carcinoma or sarcoma of the tongue in the early stage. Lymphangioma, nevus and macroglossia of the tongue, although non-malignant tumors, may, according to their severity, size and stage of progression, be indications for removal of a greater or lesser segment of the organ.

In all cases of malignant disease of the tongue an attempt should be made to remove the cervical lymph nodes which receive the lymph vessels from that portion of the tongue which is involved in the disease as well as the fascial tissues surrounding them. The submaxillary gland should also be removed because, if it is left behind, the nodes associated with it usually escape notice. When the lingual artery is ligated to control hemorrhage, the lymph nodes associated should be removed at the same time.

Except in cases in which less than half of the tongue is removed, it will be found, as a general rule, better technic to carry out resection of the tongue as the primary operation and then, a fortnight or so later, to remove the lymph nodes and tissues in the neck. Some surgeons prefer the opposite.

No matter whether the operation is a partial resection or a complete excision of the tongue, the greatest attention must be given to place the oral cavity in a surgically clean condition, as a preliminary to operation. All defective teeth should be removed. These precautions are necessary in order to frustrate, as far as possible, any provocation to septic pneumonia. For the same reasons special precautions must be taken during the operation to prevent the swallowing of blood. Some surgeons prefer to do a preliminary laryngotomy. In most cases it will suffice to plug the lower part of the pharynx with a sterile gauze packing material and to use a suction apparatus during the operation for the removal of blood and fluids.

Both before and following the operation the mouth should be washed out several times daily with a suitable antiseptic solution. This may be done easily by suspending an irrigator filled with the antiseptic solution above the head of the patient's bed and attaching to the irrigator a long rubber tube controlled by a clip and ending in a glass nozzle. The patient can then irrigate his mouth at frequent intervals by holding his head over a receptacle for the reception of the ejected solution. Not less than a week should be spent in the preparation of the mouth in this way, unless contraindicated by more important considerations.

The operations usually carried out on the tongue are:

1. Resection of a wedge-shaped piece.
2. Resection of half of the tongue.
3. Excision of the whole tongue.

The first is only permissible for a benign tumor or for a malignant condition of quite recent date and entirely limited to the lateral margin of the tongue. Most other early cases, if located in front, i.e., where the disease has not ex-

tended to the frenum linguae which forms the median septum, and is still operable, can be sufficiently dealt with by resection of half of the tongue. In extensive cases of malignant disease well within limits of operability excision of the whole tongue is called for. Nitrous oxide and oxygen anesthesia, administered intratracheally through a tube, is usually the best for these types of operation. If contraindicated use novocaine infiltration anesthesia at the base of the tongue (Fig. 179).

Fig. 179. Novocaine infiltration at the base of the tongue for operations on the tongue.

Macroglossia

REMOVAL OF WEDGE-SHAPED PIECE OF TONGUE

This pathologic increase in the size of the tongue and desmoid operative correction: the same operation is used for delimited, benign growths. (Figs. 180, 181.)

Step 1. Circumscribe the section of tongue to be removed by two semi-elliptical incisions.

Step 2. Perform a complete resection of the segment thus outlined with scalpel or scissors. Spurting blood vessels are grasped with Kelly artery forceps and secured by ligatures carried on curved needles of appropriate size.

Step 3. Approximate the raw surfaces of the sutures with interrupted silk or Pagenstecher linen sutures. Aim at exact coaptation. The bite of the needle must be deep to avoid dead spaces at the bottom of the resected segment.

Chronic Glossitis

PARTIAL MARGINAL RESECTION

This operation is indicated when the tongue is too large for the mouth and shows signs of being irritated to a dangerous degree by the teeth.

Handling and anesthesia as in Bodin's operation does not require laryngotomy. The anesthetic is given in the same manner as for cleft palate operation.

Step 1. For purposes of traction and control, the tongue is drawn well back by strong silk sutures. (Fig. 182.)

Step 2. Make a transverse incision about ½ inches long in the dorsal aspect parallel to the end of the tongue. Make a corresponding incision on the under surface. Excise a wedge-shaped piece through these incisions but leave the piece ligated by its two ends in the tongue.

Step 3. Hemostasis is effected by drawing the middle portion away from the tongue and closing the wedge-shaped incision with sutures.

Step 4. Continue the wedge-shaped excision along the margin of the tongue inserting sutures to prevent hemorrhage. Dissection is completed when

Fig. 180. Fig. 181.

Fig. 180. Removal of papilloma from tip of the tongue by V-shaped incision.

Fig. 181. Same as preceding in anteroposterior section.

the level of the last molar tooth is reached (Fig. 183.) Resect the opposite side in like manner. The [illegible] of the under surface of the [illegible] Make the dorsal incision [illegible] lingual mucous [illegible] (Fig. 184.)

[illegible] very mucous [illegible] to be excised the

Excision

may be carried out incision or (b) after lower jaw. (Fig. 1 Operation.

(b)

malignant disease is limited and there is no apparent infiltration to adjacent tissues. When the disease principally involves the lower aspect and outer margin of the tongue and has extended thence to the adjacent portion of the floor of the mouth and lower jaw it is better to split the cheek and remove the portion of the lower jaw involved as well as the involved half of the tongue. When the jaw is uninvolved and the floor of the mouth is the chief seat of infiltration incision [illegible] of the lower jaw should be the operation of choice. If the lateral and dorsal portions of the tongue are mainly involved, the diseased half of the

Fig. 285. Fig. 286. [illegible] operation for [illegible] removal of the tongue, first step.
Fig. 287. [illegible] operation, second step.
Fig. 288. [illegible] operation, completed.

tongue should be resected through the mouth and the submaxillary and cervical lymph nodes, the submaxillary gland as well as the surrounding and adjacent fascial tissues on the affected side, removed at a later date.

When the half-tongue resection is being done the lingual artery of the affected side may be ligated in the usual manner (which see) and the lymphatic and salivary nodes, etc., removed [illegible] the mouth and diseased part of the tongue are in a comparatively clean condition. If foul and septic, the latter part of the operation should be deferred.

Step 1. Insert a mouth gag between the jaws, separate the blades and draw the tongue forward.

Step 2. Introduce two stout silkworm ligatures, one into each half of the tongue an inch or so behind the tip, tie each in the form of a loop about 6 inches long. One of these is grasped by the assistant who manipulates the tongue by this means throughout the operation.

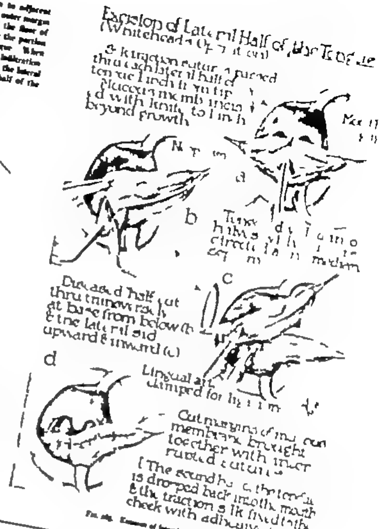


Fig. 289. Excision of lateral half of tongue.

Step 3. With a scalpel or dissecting knife make an incision in the midline through the mucous membrane on the lower and upper surfaces of the tongue. While traction is exerted laterally by means of the ligatures, the median septum is defined at the tip of the tongue by a few snips with the scissors. The operator now separates the two halves of the tongue as far back as necessary by pulling on the ligatures and dividing the tongue. (Fig. 289 a.)

Step 4. Hold both halves of the tongue toward the uninvolved side and, with scissors cut the diseased half through transversely at its base from without and below upward and inward. The lingual artery which lies near the lower aspect is picked up with pressure-forceps and, if not already ligated, doubly ligated [illegible]. Any other bleeding points are also picked up, and ligatures applied to them. (Fig. 289 b and c.)

Step 5. Attend to hemostasis. Join the cut margins of the mucous membrane with catgut. Permit the stump of the tongue to fall back into the mouth; the silkworm gut ligature which has been passed through the uninvolved half may be fixed to the cheek with a piece of strapping, if considered advisable. This ligature enables the tongue to be readily drawn forward if hemorrhage occurs as a result of the slipping of ligatures. (Fig. 289 d.)

Operation for Removal of the Whole Tongue Through the Mouth

The operation for removal of the whole tongue through the oral cavity by means of scissors is often referred to as Whitehead's operation. Strong straight blunt-pointed scissors, gag, large needle and sponge-holders are required.

Step 1. The patient is placed in the usual dorsal position. The mouth-gag is introduced on the least affected side and held firmly open by the assistant at the head. A strong ligature is passed through the anterior portion of the tongue at the junction of the anterior with the middle third. This is left long and serves as a retractor to pull the tongue forward.

Step 2. The tongue is drawn forward and upward toward the roof of the mouth and the anterior pillars of the fauces are divided. This enables the surgeon to pull the greater part of the tongue out of the mouth and thus gives better view of the parts which are being operated upon.

Step 3. The soft parts of the tongue are divided if possible one inch beyond the limits of growth, by a series of snips with the scissors from without inward and directed toward the middle line. One or two small arteries will be divided; they are picked up by the pressure-forceps and ligated. The lingual arteries, when they have not been ligated in the neck, are looked for in the anterior part of the incision on each side of the median line, and nearer the inferior surface of the organ than the dorsum. When they are seen they are seized with pressure-forceps and divided on the distal side.

Step 4. Next, the remainder of the tongue is cut through with scissors, and the entire organ removed. Care must be taken to carry the incision well beyond the limits of the disease. The lingual arteries are ligated, the cut surface of the base of the tongue is sponged, and any other bleeding points [illegible] and tied.

5. The base of the tongue may be hooked forward by passing the [illegible] into the upper part of the pharynx and exerting forward traction.

This procedure is of considerable value in the temporary arrest of hemorrhage from the lingual arteries, if they have been divided before being seized with pressure-forceps. The vessels are compressed against the posterior aspect of the lower jaw.

Step 6. Before the operation is finished, a loop of strong silk should be passed through the stump of the tongue. This is brought out through the mouth and fixed to the cheek with a piece of adhesive plaster. It will serve to pull the stump of the tongue forward, and help in the control of hemorrhage, should it occur.

Step 7. When all hemorrhage from the base of the tongue and the floor of the mouth has been arrested, the raw surfaces are sponged dry and, if possible, portions of the divided mucous membrane of the floor of the mouth in front and laterally and the base of the tongue behind are joined together by the insertion of chromicized catgut. The uncovered portion is packed with gauze and the operation is completed.

Comment. Excision of the entire tongue through the mouth is the more usual operation practised for extensive carcinoma, since this method permits complete removal of the diseased organ, and does not leave a visible scar. It must be borne in mind, however, when deciding upon the adoption of this method, that in all cases where malignant disease (carcinoma) has been present for some time, the muscles of the tongue are frequently the seat of carcinomatous infiltration, and in order to completely remove all affected tissues, certain muscles must be removed down to their attachments to the hyoid bone and the styloid process. This free removal of the muscles gives rise to considerable limitation of movement of the stump of the tongue at the floor of the mouth. The lymph vessels in some instances appear to have been the seat of carcinomatous invasion. Usually, however, the carcinomatous elements are carried direct to the lymph-nodes in the neck, and are not arrested in the course of the lymphatic vessels.

In all cases the cervical operation must also be carried out on one or both sides according to the method already described on page [illegible]. Whenever carcinomatous growth of the tongue extends to the middle line of the tongue or beyond, the lymph structures on both sides will probably become affected with the disease. Operation on both sides will then be necessary, but only one side at a time should be operated upon, the side of the affected portion of the tongue being selected first. When the carcinomatous growth of the tongue is in a septic and foul condition, it is better not to ligate the lingual artery in the neck when the tongue is removed but to remove the submaxillary and cervical lymph nodes and fascial tissues at a second operation. In septic cases of this kind, suppuration in the cervical wound is liable to occur. This may be followed by serious complications, such as cellulitis in the fascial planes of the neck and secondary hemorrhage from the lingual artery.

Excision of the Tongue with Median Incision of the Lower Lip and Division of the Symphysis of the Lower Jaw

Step 1. Make a vertical incision through the soft tissues of the lower lip and the submental region (Fig. 290) beginning at the midline of the lower lip and

The [illegible] segment is then [illegible] and toward the opposite side [illegible] the other part is pulled [illegible] and back [illegible]. These [illegible] the lateral aspect of the tongue, the floor of the mouth and [illegible] of the fauces are laid bare. When, however, a portion of the jaw is involved in the disease, the [illegible] of the [illegible] bone are [illegible] and the teeth at each extremity of the [illegible] portion is removed. [illegible] the [illegible] of the jaw is [illegible] through in front of and behind the region of the [illegible] portion. Great care must be taken to make the section of the bone [illegible] of the disease. When the bone has been sawn through, the separated portion is removed and the two segments pulled aside so as to give [illegible] exposure of the interior of the buccal cavity and the extent of the disease.

Step 3. Removal of the Tongue.—This having been accomplished, the mucous membrane of the floor of the mouth is cut through one inch beyond the margin of the diseased area. If necessary, the [illegible] of the fauces are divided and the tongue is cut through well behind the infiltrated or ulcerated portions. When only one half of the tongue is involved, the [illegible] should be divided along the midline on the dorsal and ventral aspects and the organ [illegible] back and into halves. These cutting operations can be most easily done with strong curved [illegible]. In cutting through the substance of the tongue special care should be taken, [illegible] the ventral aspect is being reached, to ascertain the position of the lingual arteries and, [illegible] these should be seized [illegible] forceps before cutting. The sublingual nodes can generally be removed at the same time as the tongue.

Step [illegible]. Closure of the External Wound.—If possible, the mucous membrane on the dorsum of the [illegible] of the tongue should be approximated to the cut margin of the mucous membrane of the floor of the mouth by [illegible] sutures. This facilitates healing and tends to prevent the stump of the tongue falling back over the upper aperture of the larynx. In those cases in which the lower jaw has been divided, and no portion taken away, the two fragments are brought in apposition, drilled with some form of bone perforator and then fixed in [illegible] by the insertion of [illegible] of silver wire. When, however, a segment of bone has been removed after all hemorrhage has been arrested, the cavity of the wound is packed with strips of gauze. Finally, the margins of the wound are fixed together by the insertion of [illegible] series of interrupted silkworm-gut sutures. Special care should be taken to secure exact coaptation at the angle of the mouth. The lowest and most dependent portion of the wound should be left unsutured, and through it either [illegible] strip of gauze or a drainage tube brought out.

When the operation has been completed, the laryngotomy tube is removed, and the external incision covered by [illegible] dressing. Before removing the tube care must be taken to remove the sponge plug from the upper portion of the pharynx and to sponge all the air-passage free from blood clots.

EXCISION OF THE CERVICAL LYMPH NODES, SUBMAXILLARY SALIVARY GLANDS AND FASCIAL STRUCTURES OF THE NECK IN CONNECTION WITH OPERATIONS FOR CARCINOMA OF THE TONGUE AND FLOOR OF THE MOUTH

Step [illegible]. Place the patient in the dorsal position, the head being turned toward [illegible] and the shoulders slightly raised in order to throw the head somewhat back[illegible]. The surgeon [illegible] on the side of the patient [illegible] is to be operated upon and his assistant opposite him.

Step [illegible]. [illegible] incision [illegible] as far back as possible in the natural fold or crease of the neck, extending from the anterior border of the sternomastoid [illegible] below the level of the apex of the mastoid process downward and forward to the middle line of the neck, about halfway between the mental process and the body of the hyoid bone. From the convexity of this [illegible]

[illegible] Fig. 287. [illegible] Photograph taken [illegible] Fig. 288. Same patient treated with radium [illegible] Courtesy of Dr. [illegible]

[illegible] a little in front of the anterior margin of the sternomastoid, make a second incision downward to the level of the cricoid cartilage or even lower according to the extent of the lymphnodal infection. Some surgeons recommend prolonging the lower limb of the incision as far back as the upper border of the sternoclavicular articulation, but in most cases, this is not necessary.

Step 3. Dissect free three flaps of skin and subcutaneous tissues—one upward, one outward and one inward.

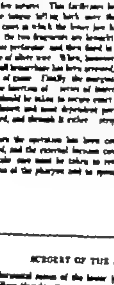
Step 4. Beginning at the angle below, dissect upward [illegible] triangular-shaped flap of fascial tissues and attached lymph nodes and vessels, until the horizontal ramus of the lower jaw is reached. Careful and meticulous dissection is necessary in order to separate all the cervical lymph-nodes along with the fascial tissues, and to avoid injury to the contents of the carotid sheath.

Step 5. Recognize and ligate the external maxillary (facial) artery in the upper part of the dissection before [illegible] enters the groove in the submaxillary gland. Isolate the salivary gland from its deep connections, ligate its duct. Remove the entire mass of cervical lymph-nodes, submaxillary salivary gland and fascial tissues by cutting through the upper attachments in the region of

the horizontal ramus of the lower jaw. During this dissection the external maxillary (facial) artery [illegible] cut and ligated as are also [illegible] number of facial veins.

Step 6. Sponge the entire space carefully so that the surgeon may be enabled to detect and ligate with catgut any small bleeding points.

Step 7. Bring the margins of the flaps, consisting of skin and subcutaneous tissue, into exact apposition and secure them with interrupted sutures of



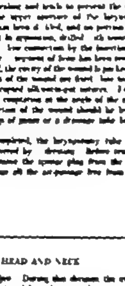


Fig. 289. Fig. 290.

Fig. 289. Carcinoma of the tongue [illegible]

Fig. 290. Same patient [illegible] following [illegible] (Clinically well over [illegible] years. Died of some intercurrent [illegible] Courtesy of Dr. [illegible])

dermal suture. Insert [illegible] small rubber drainage tube into the deep part of the wound in the submaxillary region, thus preventing an accumulation of blood and serum which might cause trouble later.

Comment. In view of the remarkable progress made in the treatment of tumors of the lips, mouth and tongue by the use of radium, this chapter would be incomplete without calling attention to the striking results obtained from the use of radium in some well-selected cases of carcinoma of the tongue. The accompanying illustrations emphasize the point clearly. (Figs. [illegible])

CHAPTER 13

SURGERY OF THE SALIVARY GLANDS

INJURIES

A buccal fistula, the result of [illegible] injury, is of slight importance. It is different when an external salivary fistula results. The divided ends of the duct should be promptly sutured whenever possible, using chromic catgut. The jaw should be immobilized, and feeding done through [illegible] tube.

ACUTE INFECTIONS

SUBLINGUAL GLAND

An abscess here [illegible] incised through the mouth in the long axis of the gland. Leave the wound open or drain.

SUBMAXILLARY GLAND

Acute suppurations here should be dealt with promptly by surgery. The tendency of the infection to extend may result in its invading the fascial planes in the neck and may cause rapid edema of the glottis calling for prompt tracheotomy.

The incision should run parallel with and just below the ramus of the mandible. [illegible] should be ample, divide the deep fascia to where [illegible] and [illegible] to avoid, if possible, the facial artery coursing at the posterior border of the gland (Fig. [illegible]). In case the artery [illegible] divided, secure the divided ends and ligate them.

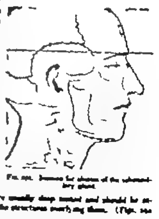


Fig. [illegible]. Incision for abscess of the submaxillary gland.

PAROTID GLAND

Here suppurations should be met with by incision over the most prominent portion of the swelling in the line of the course of the facial nerve fibers. Purulent collections in this situation are usually deep seated and should be attacked at an early date by penetrating the structures overlying them. (Figs. [illegible] and [illegible])

CALCULUS OF THE SALIVARY GLANDS AND DUCTS

SUBLINGUAL DUCT

When the calculus is not firmly imbedded here it may be removed [illegible] the duct. If it is, it is best to remove the concretion together with the [illegible]. In the former case after infiltration anesthesia, the sublingual duct [illegible] over the palpable stone in the long axis of the gland [illegible]

will aid in [illegible]) and the stone is extracted, preferably in toto. [illegible] Leave the wound open. Avoid injury to the lingual nerve.

Where the gland also is to be removed, recall that the gland rests on the mylohyoid muscle; [illegible] the lingual nerve and Wharton's duct (submaxillary).

REMOVAL OF SUBMAXILLARY GLAND

Step 1. General anesthesia (tracheal insufflation). Insert mouth gag; retract the tongue to the opposite side.

Step 2. Divide the mucous membrane and separate it from the gland by blunt dissection. Expose the gland. Pressure by an assistant from under the jaw will aid in making the gland prominent.

Fig. [illegible]. [illegible]

Step 3. Enucleate the gland from its surroundings with curved scissors. If the lingual nerve is injured there will be loss of sensation of the anterior half of the tongue. Avoid cellulitis by leaving the wound open. Injury to Wharton's duct is not of much significance.

REMOVAL OF STONE FROM WHARTON'S (SUBMAXILLARY) DUCT

The duct is superficial in situation, about [illegible] inches in length, and its walls are thin. The lingual nerve crosses the duct at the anterior border of the hyoglossus muscle.

Use infiltration anesthesia. Incise directly over the stone in the long axis of the duct in order to avoid injury to the lingual nerve. Extract the calculus. Leave the wound open.

Removal of the stone and submaxillary gland by the external route is the operation of choice where an [illegible] is present. In the latter case free drainage is of utmost importance.

Step 1. Make an incision parallel with the lower border of the mandible. Divide the tissues; expose the gland.

Step 2. Have an assistant place his gloved finger at the floor of the mouth and push the structures downward, thus making them accessible to operation [illegible].

Step 3. Enucleate the gland by blunt dissection. [illegible] forceps may be used to pull the gland forward. The divided Wharton's duct is permitted to remain behind. Do not perforate the mucous membrane of the floor of the mouth. Drain (rubber tube or cigarette drain).

CALCULUS OF THE PAROTID DUCT

Buccal Portion. The buccal portion of the parotid duct is from [illegible] to [illegible] in. long. It extends from the edge of the masseter muscle, through the buccinator to the opening on the buccal surface of the cheek opposite the second upper molar tooth (Fig. [illegible]).

Fig. [illegible]. Incision for parotid [illegible].

Step 1. Make counter-pressure on the outside of the cheek. Inject the anesthetic in the buccal tissues directly over the calculus.

Step 2. The incision is made in the long axis of the duct down to the calculus; extract it. Leave the wound open. If an internal salivary fistula forms at the site of incision, it is of no consequence [illegible].

Masseteric Portion. The masseteric portion of the parotid duct runs from the anterior edge of the parotid gland, lying on the masseter muscle, as far as its anterior edge and is about [illegible] in. long. In its posterior portion it [illegible] the duct of the accessory parotid gland. The course of the duct corresponds approximately to the middle third of [illegible] line drawn between the lower portion of the [illegible] auditory meatus and the middle of the upper lip. Its diameter is about [illegible] in. The facial nerve has branches both below and above it.

Step 1. Make an incision through the skin and superficial fascia in the line of the duct and through the duct wall to the calculus. Seize the stone with forceps and extract it.

Step 2. Ascertain the presence of stricture in the proximal or distal part of the duct. If present, dilate it with probes of increasing caliber. Coapt the edges of the divided duct with fine chromic catgut sutures which are not permitted to penetrate the lumen. Bring the skin and superficial fascia together accurately with sutures. Immobilize the jaw for several days. Feed the patient through [illegible] tube. Inaccurate coaptation of the divided edges of the duct or faulty union [illegible] may result in the formation of an external salivary fistula. Should this occur sufficient time should be

given for natural contraction, in the hope that the fistula will gradually close, before resorting to any of the plastic procedures described below.

X-ray as [illegible] therapeutic measure is, in these cases, of [illegible] value.

When the calculus is imbedded in the glandular portion of the parotid, such stones are removed in [illegible] manner similar to that employed for those found in the masseteric portion of the duct with the difference that the gland tissue over the duct is separated before the latter is incised. Remember while operating that the facial nerve [illegible] the parotid.

Step 1. Use tracheal insufflation. Make [illegible] skin incision over the calculus cutting parallel to the course of the facial nerve fibers.

Step 2. Deepen the incision through the gland until the calculus is exposed; remove it with appropriate forceps. If the stone [illegible] firmly imbedded, remove

Fig. [illegible]. Salivary calculus in [illegible] duct. Arrow points to [illegible].

little of the surrounding parotid tissue by careful scalpel dissection. When an inflammatory [illegible] of the parotid exists, the wound may be closed without drainage; the gland tissue [illegible] approximated by deep sutures preventing the development of dead spaces where salivary [illegible] might form. Close the skin carefully to avoid salivary fistula.

TUMORS OF THE PAROTID GLAND

BENIGN TUMORS

Step 1. When the parotid tumor [illegible] of large size (Fig. [illegible]) make an incision (Fig. [illegible]) over its most prominent part along the course of the facial nerve fibers.

Step 2. Separate the capsule of the gland from the surrounding glandular tissue by blunt dissection. Ligate each bleeding point separately as encountered. Control oozing with lap-pads wrung out of hot salt solution.

Step 3. Enucleate the tumor and secure [illegible] dry field. Do not use approximating sutures through the gland tissue or the capsule. The neighboring parotid

tissue crowding into the opening left by the removal of the tumor will obliterate much of the space created by the removal of the tumor.

Step 4. Carefully unite the skin edges together with the subcutaneous fatty tissue with silk sutures. Apply moderate pressure. The skin sutures [illegible] to be left in, if possible, for [illegible] days, and light pressure with bandage kept up for another week. For cosmetic reasons, [illegible] sutures may be used. It is important to bring the whole of the subcutaneous fatty layer in apposition over the wound in the gland.

Since large benign tumors tend to grow downward and outward, [illegible] flap incision [illegible] made for their exposure.

Step. The incision [illegible] anterior to the lobule of the ear and follows the posterior and inferior borders of the [illegible]

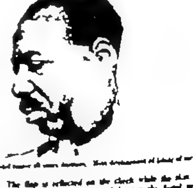


Fig. [illegible]. Benign parotid tumor of [illegible]. [illegible]

[illegible] of the jaw. The flap is reflected on the cheek while the skin and subcutaneous fatty layers are dissected upward [illegible] the facial nerve fibers on the parotid or on the growth.

Step [illegible]. The location of the capsule of the tumor [illegible] determined and the parotid gland tissue pushed away from [illegible] by blunt dissection. This [illegible] followed by careful [illegible].

Excision of the Parotid Gland

Step 1. Fig. [illegible] shows the type of incision which should be made through the skin over the region of the gland. Reflect the skin so as to expose the whole parotid covered by its fascia.

The anterior (horizontal) part of the incision [illegible] between the mastoid process and [illegible] of the mandible and extends to the anterior border of the masseter muscle. The posterior (vertical) portion [illegible] of the [illegible] muscle. Avoid injury to the branch [illegible] of the sternomastoid muscle.

external jugular vein. Walter E. Sistrunk's method of avoiding injury to the facial nerve during the removal of the parotid gland is depicted in Fig. [illegible]

Step [illegible] Mobilize the anterior edge of the gland and tumor. Ligate the blood vessels as encountered, as well as Stensen's duct. Separate the gland and tumor from the masseter muscle working from the front.

Step 3. Further mobilize and separate the lower edge of the gland from its surroundings by blunt dissection ligating and dividing all important vessels, as encountered.

Step 4. Expose the upper end of the anterior portion of the sternomastoid muscle, open its sheath and retract the muscle back[illegible]

Step 5. Expose the external carotid artery working from below upward and elevating the lower edge of the gland. Ligate the artery doubly and divide it. Mobilize the tumor and gland up to the level of the styloid process of the temporal bone.

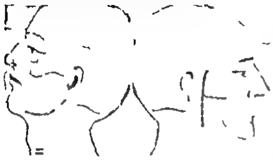


Fig. [illegible] Fig. [illegible]

Fig. [illegible] Incision for large benign tumors of the parotid.
Fig. [illegible] [illegible] incision for the removal of the parotid gland.

Step 6. Separate and sever all connections between the tumor and the temporomaxillary joint by blunt dissection. Ligate the temporal vessels at the level of the zygoma and divide them.

Step 7. Pull the gland, etc., back. The [illegible] which run along with the internal maxillary artery from behind the neck of the lower jaw into the gland are then exposed. This group of vessels is now ligated and divided.

Step 8. Separate the posterior and pharyngeal connections of the gland by blunt dissection. Take care not to injure the internal jugular vein.

Step 9. Attend to hemostasis by packing the wound. Suture the wound after providing for drainage.

Note. If there are any enlarged lymph nodes near the parotid, they should be removed at the same time. The operation is a difficult one and calls for experience.

[illegible] operation[illegible] is essentially as follows:

[illegible] [illegible] T. [illegible] [illegible] and [illegible] [illegible] Paris, [illegible]

Step 1. Make an incision downward extending from the tip of the mastoid process, continuing along the anterior border of the sternomastoid muscle to a point a little below the angle of the lower jaw. Continue this incision forward immediately below and parallel to the mandible until the anterior border of the masseter is reached; continue the incision upward along the anterior edge of the masseter and terminate it on the zygoma.

Step [illegible] Reflect the skin flap thus outlined, upward, exposing the sternomastoid muscle, the facial nerve, the parotid, the masseter muscle and the lower jaw in front of it, also the facial artery and the zygoma. With the elevator and knife expose the base of the lower jaw just in front of the masseter and divide it with Gigli saw. Divide the masseter muscle at its zygomatic insertion as well as Stensen's duct.

Fig. [illegible] Method [illegible] and [illegible] to prevent injury to the facial nerve. The facial nerve has been exposed and separated from the [illegible] portion of the parotid gland. A [illegible] is kept in front of the nerve while the [illegible] being removed. (Walter E. Sistrunk, Surg. Cl. N. Am., W. B. Saunders Co.)

Step 3. Grasp the ascending ramus of the jaw with bone forceps and dislocate it outward and backward; at the same time divide the internal pterygoid muscle; ligate the inferior dental vessels and divide the tendon of the temporal muscle. Ligate the external carotid artery immediately before it enters the parotid gland. Ligate the internal maxillary as it passes behind the condyle of the inferior maxilla. Ligate also the superficial temporal and the posterior auricular arteries.

Step 4. Remove the parotid gland and the ascending ramus of the jaw together. Investigate now whether or not the pharyngeal prolongation of the parotid gland is adherent to the carotid pocket; if so, separate the adhesions. Close the wound.

OUTERRAS' [illegible] OF TOTAL PAROTIDECTOMY UNDER LOCAL ANESTHESIA

In all parotidectomies executed by Outerras, the parotid gland is removed under local anesthesia. The skin is first infiltrated following the line of the operative incision. (Fig. [illegible])

Step [illegible] Divide the auricular nerve, ligate the external jugular vein, exposing and mobilizing the posterior border of the parotid gland which exposes the anterior edge of the sternocleidomastoid muscle. (Fig. [illegible])

Step 2. The upper part of the incision exposes the mastoid apophysis at which level a small quantity of anesthetic solution is infiltrated deeply to block the facial nerve. (Figs. [illegible], [illegible])

[illegible] de Cirug. [illegible], [illegible]

Step 3. In the lower part, following exposure of the posterior belly of the digastric muscle, a small quantity of anesthetic solution is infiltrated at the

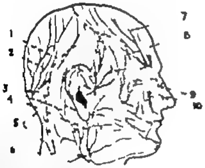
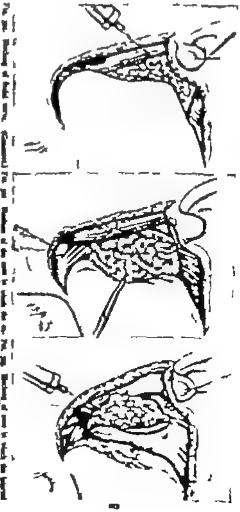


Fig. [illegible] Distribution of sensory nerves of head [illegible] [illegible]

F[illegible] [illegible] Infiltration of the skin following the line of the operative incision. (Outerras.)

[illegible] sterno-cleido-mastoid muscle; the external carotid artery is freed below the digastric and ligated.



Step 4. Free the parotid gland from the pavilion of the ear. Displace the deep-lying blocked facial nerve, expose the temporal vein and block the auriculo-temporal nerve.

Step 5. The liberation of the parotid gland at its anterior extremity is continued. The vasculo-nervous elements, Stensen's canal and branches of the facial nerve have been blocked at the commencement of the cutaneous anesthesia. The gland is freed from the masseter muscle as far as the posterior border of the internal muscle. Here a small quantity of anesthetic solution is injected and the liberation of the gland continued until the internal maxillary vessels are exposed. These vessels are ligated and the gland is totally freed.

Note. An exact knowledge of the technic is necessary in order that the blocking of the nerves may be effected at the precise time of the freeing of the parotid gland.

SALIVARY FISTULAS

Salivary fistulas may be connected with the parotid gland or its duct. In the vast majority of cases, they may be divided into two groups: (a) glandular fistulas and (b) fistulas of Stensen's duct.

In recent injuries involving the cheek, locate Stensen's duct, if possible. Fix it immediately in position so that it will discharge into the mouth.

TREATMENT OF GLANDULAR FISTULAS

Immobilization of the Jaws. Fiori reports 38 cases cured by this method. The method consists of holding the jaws together, sometimes preventing the jaws from opening for several months by such devices as intermaxillary ligatures, splints, or bandages. During the period of immobilization, only liquid nourishment is allowed and speaking is forbidden.

Dorsdall believes that many cases will heal spontaneously without immobilization of the jaws and that the fistula persists just as often in those who have been subjected to immobilization as in those who have not had the jaws closed.

Cauterization. Chemical cauterization with silver nitrate or with the actual cautery should be tried in fistulas of the glandular type. The cautery should be applied directly to the fistulous tract every few days. X-rays have of late been lauded in the treatment of glandular fistulas.

Avulsion of the auriculo-temporal nerve (running between the temporal artery and the ear) may be tried. The purpose is to diminish the secretion of the gland. Good results have been reported by the use of this method by Leriche, Duguet, Dorsdall, Touma, Leon and others. (Fig. 299, p. 274.)

Morestin considers extirpation of the fistulous tract the method of choice.

Extirpation of the entire gland should not be attempted until all other methods have failed.

Submaxillary glandular fistulas are very rare as compared with those of the parotid. Here, extirpation of the gland is the operation of choice.

FISTULAS OF STENSEN'S DUCT

Many operations have been devised for the relief of fistula of Stensen's duct. The object of this multiplicity of procedures is to divert the flow of saliva into the mouth, instead of discharging on the surface.

These operations vary with the position of the fistula: (A) where the fistula is anterior to the masseter muscle; (B) where the fistula is in the masseteric portion of the duct.

Fistulas Anterior to the Masseter Muscle

VON LANGENBECK'S OPERATION

Step 1. Pass a probe through the fistula. Make an incision on the surface as shown in Figure 304.

Step 2. Dissect the fistula and Stensen's duct from its masseteric bed, from the fistula to the gland, leaving it attached to the gland.

Step 3. Perforate the buccal mucous membrane with a delicate pointed knife, at a convenient point.

Fig. 304. Incision in von Langenbeck's operation for salivary fistula.

Step 4. Pull the free end of the mobilized duct into the mouth through the perforation in the mucosa and suture it in place here. The stab-wound should be made in such a position that there will be no tension on the duct when sutured to the mucous membrane inside the mouth.

Step 5. Close the wound on the cheek.

The object of this, von Langenbeck's operation, is to convert an external into an internal fistula. This is the operation of choice when the duct is anterior to the masseter muscle. Unfortunately however the fistulas are usually found much farther back.

DEGUISE'S OPERATION

Step 1. A puncture is made through the fistula, opening obliquely backward and inward to the inner surface of the cheek, through which is passed one end of leaden wire.

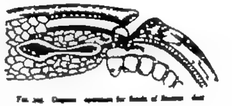


Fig. 305. Deguise's operation for fistula of Stensen's duct.

Step 2. A second puncture is then made through the same external opening, but directed obliquely forward to the inner surface, through which the other

end of the wire is passed into the mouth and united snugly. It is to follow by twisting. The parotid secretion promptly follows the leaden guide into the mouth, and the external opening quickly heals. Silver wire, silk or an elastic ligature may be used instead of lead wire. (Figs. 305 and 306.)

KAUFMAN'S OPERATION

This procedure, like the two above described, is devised for the purpose of converting an external into an internal fistula.

Step 1. A small rubber tube about 3 mm. thick is passed into the mouth through an opening made by pushing a trocar through the tissues of the cheek from

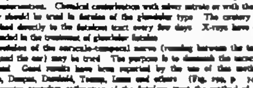


Fig. 306. A. Introduction of the wire [illegible] wire on oral surface twisted; cutaneous surface closed by suture.

the external fistula. The rubber tube is withdrawn in two or three weeks or when epithelialization of the tract has been well begun.

Step 2. The aperture of the external fistula is then freshened and its edges sutured. The rubber tubing (heavy silk cord may be substituted) may be secured in place by using a small safety pin which is passed through the outer opening. This is covered with sterile adhesive plaster to keep it attached to the skin of the cheek.

Fistula Situated in the Masseteric Portion of Stensen's Duct

Von Langenbeck's (p. 277) operation may be used if the duct is long enough and can be brought through a transverse incision in the masseter muscle to the buccal mucous membrane. The methods of Kaufman and Deguise may also be used, but the masseter should not be punctured and the ligature or rubber drain should be passed through a tunnel burrowed between the masseter and the skin.

NICOLADONI'S OPERATION

In this method a new duct is formed by a plastic procedure.

Proceed as is shown in Figures 307-308-309-310.

Step 1. Mobilize the fistulous orifice by dissecting it free from the skin. The incision should penetrate all the tissues of the cheek except the mucosa and the masseter muscle. Retract the edges of the wound, exposing the outer surface of the mucosa. (Figs. 307-308.)

Step 2. Construct from the buccal mucosa a flap with its pedicle at the edge of the masseter. The flap should be of sufficient length to reach from the masseteric edge to the fistula.

Step 3. Suture the upper and lower edges of the flap together in such a manner as to form a tube lined with epithelium. (Figs. 309-310.)

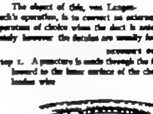


Fig. 307

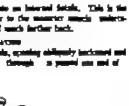


Fig. 308

Fig. 307. Divided end of Stensen's duct dissected free, shown resting on the masseter muscle.
Fig. 308. Flap of mucous membrane of the cheek dissected and displaced backward.

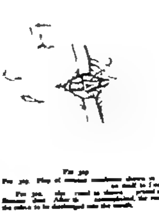


Fig. 309

Fig. 310

Fig. 309. Flap of mucous membrane shown in preceding figure sutured after being folded so as to form a tube.

Fig. 310. The wound is closed [illegible] ready to be sutured [illegible] end of Stensen's duct. After this is accomplished, the rest of the structures are so united as to allow the saliva to be discharged into the mouth.

Step 4. Close the cutaneous wound.

Crosse Operation. This operation is much the same as that of Ferrarini.

Parotid Submaxillary Anastomosis

In cases in which lesions of Stensen's duct severely interfere with the secretion of the parotid, Ferrarini demonstrated the possibility of establishing drainage through a submaxillary anastomosis between the parotid and submaxillary glands in the following manner:

Step 1. Expose the submaxillary gland by an incision running parallel to and below the horizontal ramus of the inferior maxilla. Continue the incision back to and around the angle of the jaw, thereby exposing the lower part of the parotid, the capsule of which is opened. Mobilize the submaxillary gland by blunt dissection.

Step 2. Isolate and mobilize the lower end of the parotid behind the angle of the jaw.

Step 3. Incise or resect corresponding portions of the two glands.

Step 4. Suture the raw surface of one gland to the raw surface of the other.

Step 5. Close the external wound. Drain the wound.

Ligation of Stensen's Duct

It is an established fact that when one closes off, or ligates, Stensen's duct in close proximity to the gland, the gland will atrophy. Morestin takes advantage of this fact, and in cases where other methods fail he dissects the stump of the duct free with all the surrounding tissue and then ligates it at its origin. The soft tissues are then mobilized and closed without drainage. This obliteration of the duct causes rapid atrophy of the parotid. Morestin reports gratifying results from this procedure.

[illegible]

CHAPTER 14

SURGERY OF THE JAWS, UPPER LIP AND CHEEK

OPERATIONS ON THE UPPER JAW

The superior maxilla may be removed (Figs. [illegible]) partially or as a whole for the following conditions:

Benign Tumors
Malignant Tumors
a. Sarcoma
b. Carcinoma (squamous celled or columnar celled)
Epithelioma involving all bodies
2. Carcinoma of the nasopharynx
Necrosis of the maxilla
3. Osteomyelitis

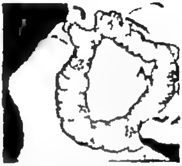


Fig. [illegible] Resection of upper jaw. Wheels show extent of subtotal infiltration. A. Post ... of the cavity for blocking the maxillary [illegible].

In removal of the superior maxilla, Kocher recommends preliminary ligation of the external carotid artery (see under ligation of arteries). His reason for this preliminary step is that removal of the upper jaw is often accompanied by excessive loss of blood or followed by aspiration pneumonia. The advice is therefore sound and has many supporters. The writer also subscribes to it. It will repay in time saved and render the operation cleaner.

EXCISION OF THE UPPER JAW

Fergusson Operation

Either one or both halves of the upper jaw may be removed by this technic. While there are a number of other surgical procedures for the removal of the upper jaw, this operation is very suitable when the skin is not involved.

Step 1. Kocher, Fergusson or Dieffenbach incisions may be used (Figs. [illegible]). Make a median incision beginning about 1 cm. below the inner canthus of the eye, continue it downward to the nasofacial groove following the convexity of the ala nasi and passing along the margin of the nostril to the median of the lip and thence through the center of the upper lip. Make a horizontal incision passing from the beginning of the median incision along the lower border of the orbit to end over the malar bone beyond the outer canthus.

Fig. [illegible] Resection of upper jaw. Total resection of upper jaw of man [illegible] years of age [illegible].

While incising from the inner canthus to the septum nasi and from the inner canthus to the malar bone, compress the facial artery over the inferior maxilla. Just before dividing the upper lip, compress on either side of the median line and, when severed, ligate the superior coronary arteries while still compressed. In making these incisions several arteries must be divided and ligated.

Fig. 303 / Fig. 304

Fig. 303. A. Incision for removal of the upper jaw. B. Incision for excision of the [illegible] of the [illegible].

Fig. 304. Incision for removal of the upper jaw. Right side Fergusson, left side [illegible].

Step 2. The flap thus outlined is dissected up. Clear the surface of the superior maxilla as completely as possible but not subperiosteally. The infraorbital artery is now divided.

Fig. 305 / Fig. 306

Fig. 305. Resection of superior maxilla. [illegible]

Fig. 306. The bone cutting [illegible] the ascending process of the upper jaw while the [illegible] of the malar bone.

Fig. 307 / Fig. 308

[illegible] of division of the palate [illegible] and pterygomaxillary [illegible] forceps [illegible] the completely detached upper jaw.

Step 3 Detach the nasal cartilages from the bone Divide the nasal process of the superior maxilla from the junction of the nasal process with the lower border of the nasal bone, to the margin of the orbit Raise the periosteum from the floor of the orbit (including the origin of the inferior oblique muscle) and retract these upward Chisel obliquely across the orbital plate to the anterior end of the sphenomaxillary fissure The orbital and external surfaces of the malar bone are now cleared The malar bone is divided obliquely through its middle with Gigli saw from the anterior end of the sphenomaxillary fissure downward and outward to the center of its free border (Figs 3[illegible] 3[illegible]6-3[illegible]7)

Step 4 Extract the central incisor tooth of the involved side Divide the muco-periosteal covering of the hard palate in the median line along the intermaxillary and the interpalatal sutures from the alveolar process to the posterior nasal spine Similarly divide the muco-periosteal covering of the floor of the nose, cutting as near the septum of the nose as possible from the posterior to the anterior nasal spine Make transverse incision across the roof of the mouth at the junction of the hard and soft palates and separate these With fine saw chisel or scissors, divide the horizontal plate of the palate and palatal and alveolar portions of the superior maxillary bone as nearly in the middle line as the septum nasi will allow

Step 5 Grasp the superior maxilla with large bone forceps and gently move from side to side to determine the position and extent of its remaining attachments The two remaining bony connections are part of the orbital plate and the union between the pterygoid processes and superior maxilla These are divided with bone forceps (Fig 3[illegible]8)

Step 6 The inferior maxilla is depressed, the outer and posterior surfaces of the superior maxilla are freed and, by means of angular bone-cutting forceps introduced into the mouth and passed up behind the maxillary tuberosity the superior maxillary bone is separated, taking care that the soft palate is held out of the way A number of arteries will have to be divided and ligated

Step 7 All bleeding vessels are secured and hemorrhage is controlled by tamponade The wound is sutured throughout Particular care is to be taken in suturing the skin to avoid disfigurement Drainage is established through the mouth

Note Preservation of branches of the facial artery is important

Dangers. 1, Hemorrhage This is prevented by preliminary ligation of the external carotid artery

2 Aspiration Pneumonia This is forestalled by preliminary laryngotomy and plugging of the pharynx

3 Shock Administer the usual shock-treatment before and after the operation

4 Secondary Hemorrhage Be on the lookout for its occurrence and treat it accordingly should it eventuate

OPERATIONS ON THE LOWER JAW

In resection of the lower jaw certain structures must be kept in mind the auriculo-temporal, the inferior dental and lingual nerves, and the nerve to the

internal pterygoid muscle the external carotid artery and the stylo-maxillary ligament (Fig 3[illegible]9) The lines of incision, depending upon the extent of bone to be removed, are those indicated in Figure 3[illegible]0

Points of injection and direction of the needle as well as general directions for infiltration anesthesia in resection are depicted in Figure 3[illegible]

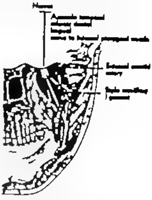


FIG. 3[illegible]9. Important structures concerned in temporo-maxillary resection and disarticulation of the mandible

TEMPORO-MAXILLARY ANKYLOSIS

Murphy's Operation

This consists of typical arthroplasty on the temporo-maxillary joint using pedicled flap composed of aponeurosis of the temporal muscle and fat The procedure is carried out as follows

Step 1. Make an L-shaped incision above the zygoma and in front of the ear as shown in Figure 3[illegible] or modified incision may be used as depicted in Figure 3[illegible]. In the former the perpendicular incision begins just in front of the ear and extends from ½ inches above the zygoma at the hair line downward to the lower border of the zygomatic arch

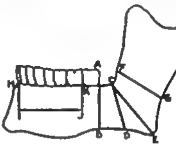


FIG. 3[illegible]0. Lines of incision [illegible] resection operations upon lower jaw

The incision then curves forward on the superior margin of the zygoma for distance of about ¾ of an inch, then curves slightly upward to avoid injuring the temporal and orbicular branches of the facial nerve This incision has much to commend it affords better access to the joint than does perpendicular incision and is certainly superior to the incisions practiced

heretofore in exposing the temporo-maxillary articulation The cicatrix resulting from this operation is slight, its greater part being hidden in the hair line

Step 2. Expose the neck of the mandible and divide with Gigli saw (Fig 3[illegible]) Separate the divided ends by traction While there are other methods devised for dividing the head and neck of the mandible at the site of the bony ankylosis (chisels, electrically driven olive-tipped dental burrs), the Gigli

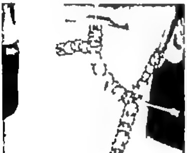


FIG. 3[illegible] [illegible]

saw method is best. Caution should be exercised in using the chisel or burr lest injury result to the internal maxillary artery or even the brain, which is in close proximity It is well to recall that the brain is separated from the head of the mandible only by very thin, transparent plate of bone

To frustrate such injuries, Murphy devised some special periosteotomes. The tip of each periosteotome passes directly beneath the neck of the mandible and the internal maxillary artery One periosteotome is placed in position from each side and all the bone lying in front of these instruments may be removed without danger Expose the joint-surface with the periosteotomes which push the tissues away all around the anterior surface of bone-union and then around the posterior surface When the bone has been bared, pass the two periosteotomes behind the neck of the bone on each

side, completely encircling the neck of the mandible behind hugging close to the head during the removal of the bone.

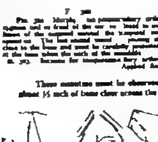


FIG. 3[illegible]2

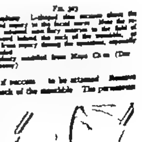


FIG. 3[illegible]3

FIG. 3[illegible]2. Murphy's temporo-maxillary arthroplasty [illegible] (FIG. 3[illegible]3. [illegible] Applied Anatomy)

These maxims must be observed if success is to be attained Remove about ½ inch of bone clear across the neck of the mandible The periosteum

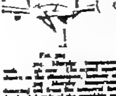


FIG. 3[illegible]4

FIG. 3[illegible]5

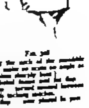


FIG. 3[illegible]6

FIG. 3[illegible]4. Murphy's temporo-maxillary arthroplasty [illegible] FIG. 3[illegible]5. Murphy's temporo-maxillary arthroplasty [illegible] FIG. 3[illegible]6. Murphy's temporo-maxillary arthroplasty [illegible] ready for closure

must be incised with and enough space created for the interposition of the fascial and fat pad A small rongeur is used to remove smaller fragments

of bone. With careful work the Gigli saw may be safely and effectually be [illegible] of proper size.

Step 3. A pedicled flap of fat and fascia is dissected from the temporal region and turned downward and inserted between the separated ends of the mandible. The flap is secured in place. The flap is [illegible] and taken from the temporal fascia and should be about [illegible] inches long and an inch [illegible]. Its base should be at the upper margin of the zygoma. Its dissection is carried from above downward. It is [illegible] over the zygoma and packed into the gap created by the removal of the bone (see Fig. [illegible]). It is secured in place by a few catgut sutures at its anterior and posterior basal angles. (Figs. 323, 325.)

Step 4. Replace the skin flap and suture it in place. [illegible] A dental splint such as [illegible] and [illegible] of the Gunning splint may be used advantageously to keep the jaws apart. (Fig. 32[illegible], p. [illegible].)

Comments. During the [illegible] of the operation no special force should be made forcibly to spread the jaws, because it is important that the mandible should remain steady on the unaffected side. Hence [illegible] wooden block inserted on the operated side prevents wide separation of the molar teeth until the flap has securely healed in its new position. By all means, avoid hematoma formation. If it occurs it may frustrate the results aimed at.

Complications. If the internal maxillary artery is inadvertently injured the external carotid must be ligated opposite the cornua of the hyoid bone. Injury to the branches of the facial nerve may be avoided by using the incision described and by careful operating. No attempt should be made to clean out the glenoid fossa. Remember that the base of the skull will surely be penetrated if the ankylosis is divided in the line of the original articulation.

Rochet's Operation

When the experience of the surgeon is limited and he [illegible] likes to avoid operative complications incident to such operations as just described, and to safeguard the facial nerve and other important structures from injury, etc., Rochet's operation may be substituted.

Step [illegible]. Make an incision at the border of the angle of the jaw; extend it along the lower edge of the horizontal ramus and about an inch along the posterior edge of the ascending ramus of the mandible. Through this incision, expose the inferior insertion of the masseter muscle. With an elevator detach the muscle from below upward, thus exposing the external surface of the mandible. Similarly expose the inner surface of the bone by separating the insertion of the pterygoid muscle.

Step [illegible]. Divide the mandible with a Gigli saw or chisel, along the lines indicated in Figure 326 and remove the section of bone between the lines shown. It is better to remove a rather larger section of bone than too little.

Step 3. From the deep surface of the masseter muscle dissect a flap about one and one-half inches long, with its pedicle above, consisting of almost half the thickness of the muscle. The free end of this flap is pulled through the breach in the bone and sutured to the pterygoid muscle. (Fig. 327.) In case the

flap from the masseter is found to be too [illegible], [illegible] at the [illegible] of the operation, [illegible] flap is taken from the pterygoid.)

Step 4. Close the wound.

Comment. Figure 328 depicts a patient in whom the resection of the coronoid process, etc., was rendered hazardous by reason of excessive callus formation and displacement of the corresponding part. I performed the

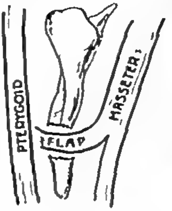


Fig. 327. [illegible] Rochet operation, after [illegible] and [illegible]. Fig. 328.
Fig. 328. Resection of mandible by [illegible] method. Patient 17 years after operation.

Rochet operation on this patient. The photograph taken 17 years later depicts the range of mobility of the jaw. He enjoys perfect control of his masticatory apparatus.

DISLOCATION OF THE JAW

Dislodge the coronoid process in front of the malar bone; depress the jaw, then push it backward. It should be kept in mind that simply pushing the chin upward only results in further displacement of the condyle and that the mouth cannot be closed for so long like movements required until the condyle is restored to its cavity.

Treatment. Place the patient in a sitting position. Stand directly in front of him. Have an assistant hold the patient's head securely. Protect your thumbs from injury when the jaws suddenly come together by wrapping them in several thicknesses of gauze. (Fig. 329.)

With palms down, place your thumbs in the patient's mouth while your fingers take a firm hold along the external outline of the mandible. With the hands in this position exert firm pressure downward and backward, maneuvering

the dislocated condyle back into its socket, aided by the action of the masseter and temporal muscles.

In some cases, especially those of long standing, [illegible] advisable to effect reduction under anesthesia.

SUBLUXATION OF THE JAW

This condition results when the cartilages of the joint slip backward causing the condyles to be thrust forward. Individuals [illegible] frequently have [illegible]

Fig. 329. Method of reduction of dislocation of jaw. Many fingers protected to avoid accidental bites from the patient.

because of this kind are able to reduce it without assistance. If the case, however, is more difficult than usual, force the mouth open by means of a wedge of wood or bone while an assistant stabilizes the jaw.

After reduction is accomplished, apply a Barton or four-tailed bandage. Retain in place for about a fortnight. Instruct the patient to be especially cautious in opening his mouth for about three weeks or until the injured capsule is completely healed.

Irreducible Dislocation

Under general anesthesia, make an incision immediately under the zygoma. Introduce a McGraw hook just over the edge of the sigmoid fossa. While an assistant firmly holds and elevates the symphysis menti, bring the condyle back into its socket with the aid of the hook.

FRACTURE OF THE LOWER JAW

Two methods of immobilization are used: (a) indirect fixation, consisting of keeping the broken fragments of the mandible in their proper relation to the upper jaw and (b) direct fixation by means of dental splints, wire or bone plates. (Fig. 330.)

Indirect Fixation

To Dr. Thomas L. Gilmer of Chicago, we owe the simple but extremely effective device, the soldered dental band, which consists of a band of thin metal made to conform to the circumference of the crown of a given tooth which is cemented in place and to which may be soldered a ring, tube or a bar. When properly applied these bands cause no damage to the teeth, and will remain in place rather indefinitely. The adjustable band, which dates back to the early part of the last century, can be applied and tightened with an appropriate special wrench. These may be obtained from the dental supply houses under the name

Fig. 330. Fractured mandible treated by direct fixation (wiring).

of Angle fracture bands. They come in two sizes, one to fit the cuspid and bicuspid and the other for the molar teeth.

Dr. Gilmer first advocated direct fixation of the lower to the upper jaw by means of the teeth as a treatment of fracture of the mandible (1887). Where applicable, this is a very simple and efficient procedure and has a broader field of usefulness than any other means at the disposal of either surgeon or dentist. Fixation may be done by dental bands (Fig. 33[illegible]) or by wires fastened directly to the necks of the teeth (Fig. 331).

If bands are used, the jaws are fixed by silk or fine wire ligatures that extend between the bands, each band having a lug or button on its outer surface [illegible] this purpose. The use of bands has certain points in its favor over the

wiring of the teeth, but the latter is the more practical method; the materials required are nearly always at hand, and can be applied by any surgeon with pair of artery forceps, pair of scissors or wire cutters.

The disadvantage of this method is that in order to open the mouth the wires have to be cut, and if it is found desirable to continue the fixation, the whole procedure may have to be repeated on teeth already sore from traction. However Blair states that "if one will refrain from the exercise of unwarranted curiosity the necessity of reapplying the wires will not often arise." Blair counsels soft iron wire that can be obtained on spools from the hardware shop, or in rolls at any florist, using No. 24 for the molars and cuspids, and No. 26 for the incisors. This iron wire is very pliable and does not stretch, but if it cannot be obtained, soft brass, copper or silver wire may be substituted. The wire is cut into

Fig. 331

Fig. 332

Fig. 331. Diagram showing fracture reduced by wiring the lower to the upper jaw by means of Angle's fracture bands.

332. Gilmer method of wiring. Fixation of the jaw by fastening the lower to the upper jaw by means of wires passed around the necks of the teeth.

lengths of about 15 cm. each, is bent in the middle, and by means of forceps is passed from the lingual surface through the interdental spaces on each side of the tooth to be ligated. An assistant holds the intra-oral loop of the wire well down on the neck of the tooth, while the operator, having obtained firm grasp on each end, makes twist of two full turns. This is the most important part of the application of the wire ligature. It should grasp the neck of the tooth so firmly as to preclude any motion. The ligature can be tightened. It, however, but it is better to get the tension while the first twist is being made. The serrations on the jaws of the forceps weaken the wire wherever they grasp it. The upper wires are being twisted together with the lower and the teeth should be held in occlusion by pressure from below the chin. It is also very important that the teeth be held in occlusion while the wires are being tightened.

Wiring of Fractured Mandible

OPEN FIXATION

Step 1. Make an incision about inches in length, or longer if need be, extending along the lower border of the jaw. Avoid injuring the facial nerve while working in its vicinity (posterior border of the masseter at the level of the lower border of the lobe of the ear). Deepen the incision to the bone.

The facial artery and vein will, of course, have to be divided between two ligatures. Secure hemostasis.

Step 2. Raise the soft tissues covering the jaw except the periosteum on both surfaces of the mandible. Freely expose the site of the fracture. Separate the insertions of the masseter and internal pterygoid muscles from the bone. Drill holes in the bone at either side of the fracture at the most advantageous points, while steadying the bone with bone forceps. Pass appropriate wires through the drill holes. The wire when placed should cross the line of fracture at right angles. While drilling the bone have an assistant hold flat retractor on the opposite side of the mandible to prevent the drill from injuring contiguous soft structures. Immediately after hole is drilled the wire should be passed through it; this will avoid trouble in finding it later. The drill holes should be large enough to admit doubled wire. Blair recommends an admirable method of inserting No. 20 piece of silver wire; this is shown in Figure 333. The wires

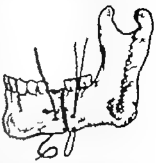


Fig. 333. Blair method of passing wire from the deep surface of the bone. The silver wire is passed through the first hole from the external to the internal surface. A loop of another wire is passed through the second hole . . . the first wire . . . caught in the loop of the second and drawn through the second opening.

Step 3. Close the superimposed soft structures with silkworm-gut sutures. Provide for drainage.

Comments. Lane plates of proper size (mm. long, mm. thick and 5 mm. wide) may be used. Dental splints may also be used to advantage.

RESECTION OF THE ALVEOLAR PROCESS

Step 1. Make an incision of the lower periosteum around the portion to be excised.

Step 2. Remove the affected area with chisel and mallet, or if the growth is small, with rongeur forceps. Have an assistant support the chin while you remove the growth. Where the lesion demands more extensive resection two vertical incisions may be made with Gigli saw (Fig. 334). The lower ends of the vertical incisions are joined by horizontal one made with chisel.

PARTIAL RESECTION OF THE HORIZONTAL RAMUS OF THE LOWER JAW

Step 1. Make an incision through the skin down to the bone along the inferior border of the mandible.

Step 2. Separate the soft tissues from both the inner and outer surface of the jaw. In necrosis, preserve the periosteum. In tumor sacrifice it.

Step 3. Remove the teeth overlying the segment of bone to be removed. With

Gigli or Jaeger saw make vertical incisions outlining the segment to be removed. Remove the segment between the two vertical incisions. Wherever possible leave ledge of lower jaw behind. (Figs. 335-336.)

Step 4. Close the wound. Drain. Metal splints (Lane plates) or tibial grafts may be used to bridge the gap. (Fig. 337.)

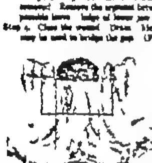


Fig. 334. Partial resection of the alveolar process of lower jaw in case of epulis. In dotted lines probable complete resection of the bottom portion of the inferior maxilla.

RESECTION AND EXARTICULATION OF THE LOWER JAW

The resection may be unilateral or bilateral.

Indications. Partial Removal: (a) epulis (Fig. 338); (b) epithelioma arising at the floor of the mouth and secondarily invading the gum; (c) epithelioma or myeloid sarcoma of the mandible; (d) necrosis of the mandible (Figs. 339-340).

Step 1. Begin the incision in the middle of the chin (Fig. 341), continue it down in front of the chin, thence along the lower border of the mandible and upward along the posterior border of its ascending ramus, ending about opposite the center of the ascending ramus. Along its entire extent the incision carried through skin, fascia, the platysma

Fig. 335

Fig. 336

Fig. 335. Partial resection of median portion lower jaw. The median portion of the mandible has been removed, from the denuded surface . . . the bone on each side . . . of the lingual and mylohyoid muscles . . .

Fig. 336. Removal of lingual to . . . muscles. The denuded surface of the mandible . . . from . . . by the suture.

myoides muscle and periosteum to the bone except near the facial artery where the skin alone is incised; the artery is then being exposed, doubly ligated and cut. (Fig. 342.)

Step 2. Raise the structures covering the outer surface of the lower jaw subperiosteally, working from the free border of the bone toward its alveolar

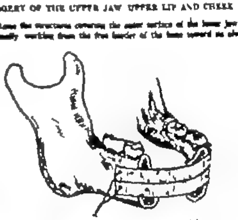


Fig. 337. Metal splint used after resection of the mandible.

margin and from the symphysis menti toward the angle and upward along the ascending ramus of the mandible. Divide the mental vessels and nerves

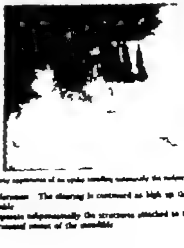


Fig. 338. X-ray appearance of an epulis extending externally the . . . of the lower jaw.

at the foramen. The clearing is continued as high up the ascending ramus as possible.

Step 3. Separate subperiosteally the structures attached to the inner aspect of the horizontal ramus of the mandible.

Step [illegible] the inferior [illegible] the [illegible] border [illegible] of the outer and inner sides of the [illegible]. Free the [illegible] from both aspects. If the bone [illegible] of [illegible].

Fig. [illegible] Fig. [illegible]

Step 5. Grasp the anterior end of the severed segment and draw it outward; detach all remaining structures from its inner aspect. If not already done, the mylohyoid muscle and the posterior part of the genioglossus of the mouth are now separated.

Fig. [illegible] Incision for excision of the mandible.

Step 6. Firmly depress the anterior portion of the inferior maxilla (Fig. [illegible]). With blunt scissors, detach the temporal muscle from its insertion. Resect the coronoid process as accessible as possible. Approach it from below rather than from behind. Care should be exercised to avoid injuring the important structures near the upper half of the posterior border of the ascending ramus of the mandible.

Step 7. Free the insertion of the external pterygoid muscle with elevator or blunt scissors by following along the upper and inner aspect of the condyloid process. Divide the joint capsule

and [illegible] the head of the bone forward. Sever any remaining ligaments and fibrous bands of [illegible].

Step 8. [illegible] the wound temporarily through the posterior portion of the incision [illegible] carefully to avoid tearing.

Note. [illegible]

[illegible] after removing a segment of the lower jaw [illegible] perforated metal [illegible] to keep the ends of the bone in correct position

Fig. [illegible] Fig. [illegible]

Fig. [illegible] [illegible] A [illegible] placed behind the bone to protect the soft parts from the saw.

[illegible] The bone divided at the middle, is now almost detached. The [illegible] of the temporal muscle [illegible].

tion (Figs. 3[illegible] and [illegible]). The metal plates are protected with rubber tubing. The mucous membrane of the floor of the mouth and cheek is sutured together below the metal plate so that the plate lies exposed in the oral cavity. The temporary plate is removed as soon as proper dental prosthesis can be substituted. [illegible] celluloid prosthesis [illegible] half of the mandible has been removed. Macewen implanted [illegible] piece of rib between the divided ends of the jaw. If properly performed, free transplantation of bone is the method of choice. The transplant [illegible] obtained from [illegible] portion of rib, [illegible] tibia, spine of scapula or metatarsal bone.

NERVE ANASTOMOSIS FOR FACIAL PARALYSIS

Historical Notes. The first operation for nerve anastomosis was performed by Ballance and Purves in 1895. [illegible] operated in 1898 and in 1901 Robert Kennedy divided the facial nerve in [illegible] case of severe facial spasm. He then sutured the proximal [illegible] of the distal portion of the facial to the partially divided spinal accessory nerve. A perfect result was obtained. Cushing successfully operated in 190[illegible].

Anatomic Considerations. The facial nerve [illegible] deeply seated in the stylomastoid foramen from which it emerges. Its course from here [illegible] downward, outward and forward, finally winding round the styloid process. [illegible] then runs forward horizontally until it crosses the posterior auricular artery into the parotid gland. The horizontal portion of the nerve is found about [illegible] inch below the lower border of the zygomatic arch at the level of the top of the lobule of the ear.

The hypoglossal nerve leaves the skull through the anterior condylar foramen and lies on the inner side of the deep cervical vessels. As it descends, the nerve comes forward between the internal carotid artery and jugular veins to the lower border of the digastric muscle where it curves forward round the origin of the occipital artery, the sternomastoid branch of which turns downward over the nerve. From this point the nerve runs forward above the hyoid bone, passes under the tendon of

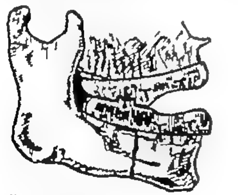


Fig. [illegible] Modified Gunning splint, applicable in resection where the parts are to be kept apart. The splint consists of two pieces fixed together after each half of the splint has been put in place by [illegible] [illegible] simpler than the original Gunning splint. [illegible]

the digastric, the lower end of the stylohyoid and the mylohyoid muscles, and crosses the external carotid and lingual arteries.

The external, spinal or cervical portion of the spinal accessory nerve runs through the jugular foramen from the skull and then passes downward, outward and slightly backward in front of (or a few instances behind) the internal jugular vein between it and the occipital artery [illegible] crosses perpendicularly. Its course [illegible] between the transverse process of the atlas and the posterior border of the digastric. The nerve next passes behind the posterior border of the parotid and enters the sternomastoid [illegible] inches below the apex of the mastoid process.

Anastomosis Between the Facial and Spinal Accessory Nerves

Step 1. Make an incision along the anterior border of the sternomastoid muscle. Begin above in the groove between the external ear and the mastoid process at the level of the tragus and terminate the incision at a point about 3 inches lower.

Step 2. Retract the ear forward. Divide the fibrous tissues covering the mastoid

process in order to gain access to its anterior border. Expose the anterior border of the sternomastoid.

Step 3. By blunt dissection, penetrate between the parotid gland and the anterior border of the mastoid. Move the dissecting instrument horizontally and vertically in an endeavor to avoid injuring the facial nerve. According to [illegible] the nerve should be found at a depth of a little less than [illegible] inch

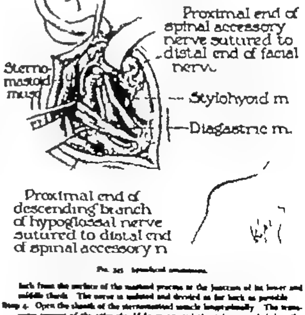


Fig. [illegible] Spinofacial anastomosis.

inch from the surface of the mastoid process at the junction of its lower and middle thirds. The nerve is isolated and divided as far back as possible.

Step 4. Open the sheath of the sternomastoid muscle longitudinally. The transverse process of the atlas should be recognized about [illegible] inch below the mastoid process [illegible] should be clearly exposed by bluntly dividing the fibrous tissues covering it. The posterior belly of the digastric muscle in front [illegible] the atlas is recognized. The spinal accessory nerve lies between the [illegible] verse process of the atlas behind and the digastric muscle in front [illegible] is isolated.

Remaining alae of the nose should also be separated from their bony attachments. (Figs. 359 and 360.)

c. Pinning and paring of the borders of the cleft with a sharp pointed knife or scissors. (Fig. 361.)

Fig. 359 Fig. 360

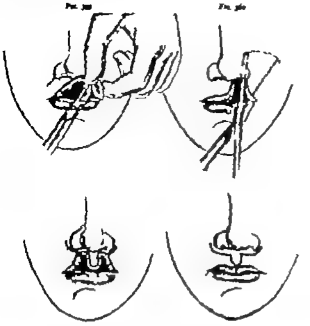


Fig. 361 Fig. 362

Fig. 359. Operation for simple harelip. [illegible]

Fig. 360. Same operation. [illegible]

Fig. 361. Operation for simple [illegible] harelip. [illegible]

Fig. 362. Same operation. [illegible]

d. Approximation of the freshened surfaces of the cleft. Careful union of the vermilion border of the lip. (Fig. 362.)

Comment. The lip line must reach from one side of the newly formed lip to the other in an uninterrupted curve. The mucous membrane on either side of the line of suture must be of equal depth. The newly formed lip should be lengthened sufficiently to cover the gums. The nostril should be

of the same size and made to the same contour as the normal nostril. The nose should not be flattened on the affected side.

If the gap is wide and the controlling muscles strong, and the cleft takes in all of the soft palate or part of the hard palate, it may be necessary

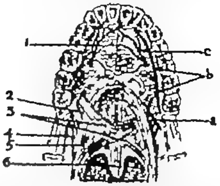


Fig. [illegible]. Muscles of the soft palate. [illegible]

to overcome muscular influence before uniting the cleft by dividing the constricting muscles (tensor and levator palati, the palato-glossi and palato-pharyngei). If these are incorrectly divided the velum will remain flabby

Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible]. [illegible]

and [illegible]. Their relations to the adjoining [illegible] are shown in Fig. [illegible]

By dividing the posterior pillars of the fauces, of which they form the principal part, the palato-pharyngeal muscles may be cut with a pair of

blunt-pointed scissors. The palato-glossi muscles, which include the anterior pillars, may be divided in the same manner. After passing a silk thread through the velum on each side of the cleft at points corresponding to the origin of the uvula, keeping the ends of the threads and making the velum firm with traction, the remaining muscles are divided. (Fig. [illegible])

The Tensor Palati. The hook-shaped process around which the tendon of the tensor palati runs is located a little behind and internal to the upper posterior molar tooth. The segment of velum is made rigid by a traction suture and the point of a narrow-bladed knife is introduced a little below and at the inner side of the process with the cutting edge upward; the knife is carried upward, backward and inward until the point is visible through the gap. The entire width of the velum together with most or all of the tendon of the tensor palati is divided.

Fig. [illegible]. Simple bilateral harelip. Outlining the incisions.

Fig. [illegible]. Same operation. After loosening the flaps they are united as shown.

The Levator Palati. Many of the inner fibers of this muscle will be divided during the above procedure. However, if greater section is required, the handle of the knife is depressed and carried outward making an oblique incision on the posterior surface of the velum as it is withdrawn.

König's Operation for Single Harelip

Step. Two more or less vertical incisions are made parallel to the borders of the cleft and passing through the entire thickness of the halves of the lips, from the upper limit of the cleft through the vermilion border. (Fig. [illegible])

Step 2. Auxiliary incisions are now made above the borders of the lips slanting from the more vertical incisions slightly downward. The incision at the outer side of the cleft is somewhat the longer. As a result of these incisions the vertical and horizontal openings shown in Figure [illegible] result.

Step 3. Pull the flaps downward and after thorough mobilization suture them as shown in Figure [illegible]

Operation for Simple Bilateral Harelip

Step. Freshen the central portion of the defect on both sides.

Step 2. Make lateral flaps with their attachments below at the outer borders.

Step 3. Separate the [illegible] of the lips.

Step 4. Approximate the freshened flaps (Figures [illegible]).

Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible]. [illegible] bilateral harelip. [illegible]

Fig. [illegible]. Same operation. [illegible]

Fig. [illegible]. Same operation completed.

Malgaigne Double Flap Method

Figures [illegible] depict the incisions, flap formation and suture of this procedure.

Ferdinand C. Lee ably discusses the principles underlying the repair of double harelip. He stresses that the important points in the operation are: (a)

Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Malgaigne [illegible] outlining flaps.

Fig. [illegible]. [illegible]

Fig. [illegible]. [illegible] completed.

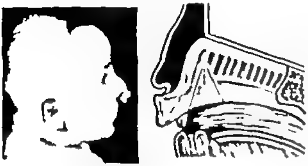
the preservation and utilization of the tissues at hand; (b) the symmetrical approximation of the two lateral flaps, with an abundance of orbicularis oris muscle; ( ) the careful suturing of the denuded surfaces with absorbable sutures; (d) the approximation of muscular tissue in the midline and the ample use of sutures to insure complete rest for the wound. Lee finds that by this method a surgeon with relatively little experience in plastic surgery may achieve satisfactory results in double harelip operations.

Jour. of the Med. Assn. of Georgia, October, [illegible]

Projecting Intermaxillary Bone

A variety of methods have been suggested to remedy th[illegible] (F[illegible] 574) [illegible] suggested [illegible] removal of [illegible] [illegible] portion of the vomer (F[illegible] 575). [illegible] and [illegible] [illegible] cured [illegible] surgeons [illegible] to subperiosteal resection. [illegible] accomplished by [illegible] the [illegible] together [illegible] [illegible] through [illegible] placed [illegible] side of the edge of the vomer.

[illegible] single vertical incision through the bone [illegible] [illegible] [illegible] [illegible] the bone [illegible] [illegible] He then



F[illegible] 574 F[illegible] 575

F[illegible] Projecting intermaxillary [illegible]

F[illegible] 575. [illegible] for [illegible] [illegible] [illegible] [illegible] [illegible]

[illegible] the deformity resulting in an overlapping of the [illegible] of the vomer. [illegible] is followed by union of the opposed surfaces. Some surgeons advise complete removal of the projecting process. [illegible] I do not concur. [illegible] pointed out that the removal of [illegible] triangular section is followed, after operation, by an [illegible] displacement of the incisor teeth. This is obviated by quadrangular resection (Figs. 576-577, 578, 579).

Step [illegible]. Retract the divided [illegible].

Step [illegible]. Remove the triangular section [illegible] strong scissors.

Step 3. Force the projecting portion into place.

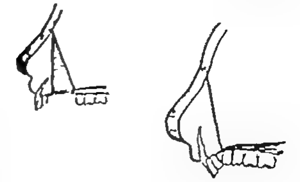
Step 4. Proper [illegible] and [illegible] support keep the soft parts in position.

OPERATIONS FOR CLEFT PALATE

(Uranoplasty. Staphylorrhaphy)

Historical Notes. The first successful cleft palate operation [illegible] executed by von Graefe in 1816. In 1819 Roux reported [illegible] operation. Dieffenbach made large lateral incisions on the palate. Fergusson divided the muscles of the palate

In [illegible] [illegible] first [illegible] to perform an oper[illegible] [illegible] cleft in the hard palate [illegible] [illegible] of [illegible] [illegible] [illegible] in the middle [illegible] [illegible] the further development of the operation



F[illegible] 576 Fig. 577

F[illegible] 576. [illegible] [illegible] [illegible] [illegible] [illegible] resection of nasal septum [illegible] [illegible]

F[illegible] 577. [illegible] [illegible] [illegible] [illegible] resection of nasal septum [illegible] [illegible]

Fig. 578 Fig. 579

F[illegible] 578. Outline of quadrangular resection of the nasal septum [illegible] for reduction of the [illegible] [illegible] [illegible]

F[illegible] 579. [illegible] of [illegible] [illegible] to [illegible] position [illegible] resection of nasal septum [illegible] [illegible]

[illegible] von Langenbeck, Brophy, Lane, Codivilla, [illegible] [illegible], [illegible], [illegible] and others.

The best time for operating on cleft palate is between the second and fifth years. The operation may be followed by serious consequences. Brophy maintains

that the proper time to operate for cleft palate is [illegible] the patient is less than three months of age.

The Brophy method of operating for cleft palate is inapplicable to children over [illegible] months old. It should be done before closing of an accompanying harelip.

Brophy Operation

Step 1. Place [illegible] traction suture in the anterior end of the tongue.

Step 2. Pare the bony edges of the cleft in the palate [illegible] pare or horizontally split the edges of the cleft in the soft palate.

Step 3. Thread [illegible] Brophy needle with [illegible] strong silk or [illegible] loop-suture. Pass the threaded needle through the superior maxilla from without inward

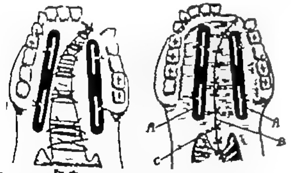


Fig. 580 [illegible] 581

Fig. 580. Brophy [illegible]. Method of inserting [illegible] sutures and application of lead plates.

Fig. 581. Brophy [illegible] [illegible] of edges of cleft by means of [illegible] [illegible] on silver wires. A-A, lead plates, B, [illegible] palate, C, [illegible] [illegible]

[illegible] [illegible] just back of the malar process and above the palate [illegible] [illegible] appears in the cleft, pick up the thread and withdraw the needle. Pass [illegible] threaded needle through the corresponding part of the opposite bone in the same way, the second loop of thread being passed through the first and both pulled out. By means of this thread, pull [illegible] strand of very strong silver wire through the same track.

Step 4. In the same way pass one or two other silver wires through the anterior portion of the maxilla above the level of the palate.

Step 5. Pass the ends of the silver wire through holes in lead plates which have been molded to fit the convexity of the buccal surfaces of the bones, then draw the wires tight and twist them together. Press the two maxillary bones together until the cleft is completely closed, twisting the wire sufficiently so as to hold the bones firmly together (Figs. 580-581).

Berry and Legg Operation

Step [illegible]. Detach the mucoperiosteal structures of the palate from the oral surface of the bony palate (Fig. 582). Make [illegible] small incision near the alveolar border. Insert into this opening [illegible] raspatory or periosteal elevator. By [illegible] [illegible] motion and with the back of the instrument against the bone, the instrument is made to advance until its tip emerges at the margin of the cleft through which [illegible] is pushed. Withdraw the raspatory. Introduce an ordinary aneurysm-needle through the opening at the inner aspect of the cleft and work it backward and forward until the necessary amount of mucoperiosteal

Fig. 582 Fig. 583

Fig. 582. Berry and Legg [illegible] operation for cleft palate. Position of first incision and [illegible] of [illegible] [illegible] [illegible] between the mucoperiosteal flap and the surface of the hard palate.

Fig. 583. Berry and Legg's operation for cleft palate. Passing of blunt [illegible] (aneurysm needle) into the wound at the edge of the cleft palate. Dotted area indicates the extent to which the mucoperiosteum [illegible] detached from the bone.

tissue [illegible] separated from the hard palate (Fig. 583). Repeat the same procedure on the opposite side. Temporary pressure arrests bleeding. Insert into the wound at the edge of the cleft [illegible] rectangular knife and extend the incision in [illegible] posterior direction to the point of junction of the soft and hard palates.

Step [illegible]. The authors consider this step the most important one of the operation, stressing that, if not properly and completely accomplished, closure of the cleft in the soft palate without undue tension will become impossible.

T[illegible] accomplish this, insert one blade of [illegible] pair of sharply curved blunt scissors into the space between the inferior surface of the hard palate and the mucoperiosteal flap where the hard palate joins the soft palate (Figs. 582-583). The other blade of the scissors is introduced over the nasal surface. In doing this the length of the incision should not be too large in order to avoid injury to the posterior palatine artery.

Step 3. This consists of paring of the margins of the cleft and is performed by grasping with appropriate forceps, the edge of the cleft opposite the [illegible] [illegible] portion of the soft and hard palates—now separated. Thread [illegible] very

fine, sharp scalpel through the whole thickness of the soft palate, transfixing as far as the notch. Withdraw the scalpel and reinsert somewhat posterior to the forceps at the same distance as the first and continue the incision toward the uvula.

Step 4. This consists of suturing the pared edges. An appropriate needle armed with Pagenstecher linen has served me well in this step of the operation. The needle is passed about 4 mm. from the freshened edge, and made to emerge on the nasal side and enter on the same side on the opposite flap. The tie is to be made in such a manner that eversion toward the buccal side results. Traction steady all flaps while the sutures are placed. They should be only approximated and not too tightly tied—lest strangulation

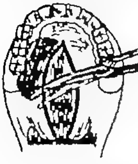


Fig. [illegible]

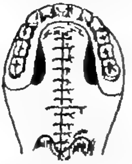


Fig. [illegible]

Fig. [illegible]. Berry and Legg operation. Introduce curved scissors and detach the soft from the hard palate.

Fig. [illegible]. Berry and Legg operation. Union of freshened edges of flaps. Dark areas indicate the incisions to relieve tension.

fix marginal necrosis result. A tension suture here and there may be of value.

Step 5. Make lateral incisions to relieve tension wherever deemed advisable. These should be made somewhat in front of the junction of the hard with the soft palate near the alveolus and internal to the posterior palatine foramen; these incisions must not be too long, too much to the front or toward the middle line.

Von Langenbeck Operation

(Fig. [illegible])

Step 1. Pare the margins of the cleft. Grasp the uvula with an appropriate tenaculum forceps. With a fine sharp pointed knife begin the freshening behind the tenaculum and excise a strip along the soft and hard palates in such a manner that a bleeding, wide, freshened margin results. Begin the resection at the hard palate to be finished at the uvula. Use fine scissors. Treat the opposite side in the same manner. Clear the nasopharynx of accumulated blood. Tampon the cleft with gauze.

Step 2. Make lateral incisions through the hard palate and extend them as shown in Fig. [illegible].

Step 3. Detach the mucoperiosteal flap from the hard palate as described in the Legg and Berry operation. This is followed by separating the soft palate from the horizontal portion of the palate-bone at the margin of the cleft, but laterally it is left attached to the bone. Next, approximate the two halves of the soft palate by blunt dissection. The mucoperiosteal flaps must be detached sufficiently to allow apposition of their freshened surfaces. These

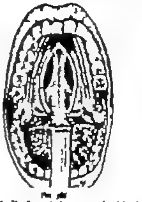


Fig. [illegible]

Fig. [illegible]

Fig. [illegible]. Von Langenbeck operation for cleft palate. Lateral incisions and freshening of edges.

Fig. [illegible]. Von Langenbeck operation for cleft palate. Note lateral incisions and approximated freshened edges thus covering the cleft.

must meet without tension. Treat the opposite side in exactly the same manner.

Step 4. Union of the pared edges. Use fine silk or Pagenstecher linen. Interrupted sutures are simplest and easiest to place. Pack lightly.

The Davis-Colley Operation

Step 1. Make a triangular-shaped flap comprising all of the soft parts taken from the wider part of the hard palate. The apex of the flap is situated behind the insertion of the incisor teeth; the base of the flap should extend forward and backward from the border of the alveolus of the last molar tooth to near the border of the cleft of the soft palate close to its attachment to the bone.

Step 2. Make a somewhat similarly shaped flap at the other side of the cleft, the inner border of which remains continuous with the soft parts at the border of the defect.

Step 3. With an elevator raise the flap last formed from the bone and turn it over across the cleft, while remaining attached at its inner border by a hinge of mucoperiosteal tissue.

Step 4. Join this flap by means of two or three catgut sutures to the freshened opposite border of the defect.

Fig. [illegible]

Fig. [illegible]

Fig. [illegible]. Davis-Colley operation for cleft palate. Flaps marked out.

Fig. [illegible]. Same as before. Flaps sutured.

Step 5. Similarly lift the first flap and bring it across to the opposite side joining its apex with the outer margin of the opposite flap by two or three silkworm or silkworm-gut sutures. (Figs. [illegible]–[illegible].)

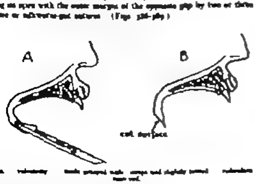


Fig. [illegible]. [illegible] [illegible] [illegible] slightly curved [illegible] [illegible].

Comment. This procedure is less severe than the other operations described; it is accompanied by less hemorrhage, pressure of the tongue against the roof of the mouth is less harmful, while necrosis and the possibility of [illegible] are not so pronounced.

Sir Arbuthnot Lane's Operation

is an adaptation of the Davis-Colley method. It is an ingenious procedure and beset with many technical difficulties to be surmounted only by the hands of the expert. It should not be attempted by surgeons who have no special training in this work. For the general surgeon, the methods described above will suffice in the vast majority of well-selected cases.

Elongated Uvula

Have the patient withdraw his tongue aided by a dry towel. Grasp the end of the elongated uvula with appropriate forceps, pull it forward and remove the desired segment with scissors. (Fig. [illegible].) The slight discomfort following the operation may be relieved by the application of a [illegible] solution.

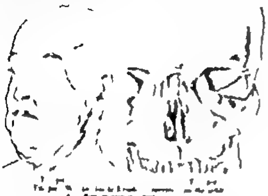
CHAPTER 18

SURGERY OF THE ORBIT AND EYE

OPERATIONS ON THE ORBIT

INCISION FOR ORBITAL CELLULITIS

[illegible]



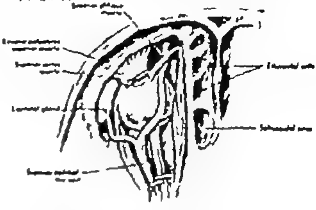
[illegible]

OSTEOPLASTIC RESECTION OF THE OUTER WALL OF THE ORBIT

Krönlein's Operation [illegible]

[illegible]

[illegible]

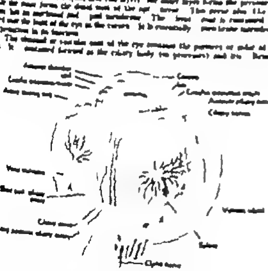


[illegible]

OPERATIONS ON THE EYE

Anatomic Considerations [illegible] The eyeball has three coats, viz. [illegible] the sclera [illegible] vascular middle coat, the choroid and [illegible] the retina.

[illegible]



[illegible]

[illegible]

The dilator fibers of the iris, the unstriped muscle of the upper eyelid, and the unstriped muscle of Müller which bridges the sphenomaxillary (inferior orbital) fissure are supplied by the cervical sympathetic. If this nerve is paralyzed, contraction of the pupil, slight ptosis and recession of the eyeball take place according to Horner's syndrome.

The two divisions of the lacrimal gland are known as the orbital and palpebral. The orbital is found in a fossa on the frontal bone and the palpebral extends downward beneath the upper eyelid, to the superior fornix of the conjunctiva. The ducts from both portions of the gland open into the superior fornix. Tears reach the puncta lacrimalia by crossing the conjunctiva. These tiny openings are found on the very top of the lacrimal papillae which occupy the margins of the eyelids close to the inner canthus of the eye. The puncta enter the lacrimal canaliculi at first running vertically and then turning abruptly inward to open by a common canal into the outer part of the lacrimal sac. Normally the puncta are placed opposite the conjunctiva, but the lower punctum may be everted causing the tears to flow over the lower lid onto the cheek (epiphora). Obstructions of the lacrimal passages often found where the lacrimal sac and naso-lacrimal duct join also cause this condition.

The lacrimal sac is formed by the dilatation of the upper extremity of the naso-lacrimal duct. Its upper end is found back of the internal tarsal ligament and is covered by some of the fibers of the orbicularis palpebrarum muscle. When abscesses form in this sac, they are likely to discharge through the skin below the internal tarsal ligament, if unrelieved, and may be opened at this situation.

The naso-lacrimal duct is about ½ inch long, extending downward and slightly backward within a bony canal and opening into the inferior meatus of the nose. By extending a line from the inner canthus to the front of the first molar tooth, its course may be indicated on the surface. The lower eyelid is everted and the lower punctum identified when a probe is passed along the lacrimal passages. The probe is inserted through the lower punctum and is directed first vertically and then horizontally toward the inner wall of the sac; then it is turned downward vertically and slightly backward toward the inferior meatus.

The eyelids are composed of five layers. Each from the external to the internal are (1) the skin, (2) the subcutaneous tissue, (3) the muscular layer (4) the tarsal plates, and (5) the conjunctiva.

The skin of the eyelid is very fragile. The subcutaneous tissue is loose in texture, quite elastic and free from fat. Oedema accompanying inflammation of the orbit and surrounding structures is generally quite noticeable in the eyelids. The muscular layer is composed of the orbicularis palpebrarum in ring like construction and some involuntary muscle which is discerned more clearly in the upper lid than in the lower.

The tarsal plates are two very thin layers of dense fibrous tissue found in the border of their respective lids and connected to the palpebral ligaments at their extremities. The Meibomian glands resemble sebaceous follicles in structure and lie between the tarsal plates and the conjunctiva. Upon everting the eyelid, the ducts may be seen through the conjunctiva as thin yellowish streaks running out freely. A Meibomian cyst appears on the deep surface of the eyelid and is likely to become quite large before it is noticed. The glands of Moll which resemble modified sweat glands and the glands of Zeiss which resemble sebaceous glands lie along the free border of the eyelids. If the glands of Zeiss become obstructed or infected a sty (hordeolum) results.

The Conjunctiva. The ocular surface of the lids is lined with the palpebral portion of the conjunctival sac while the adjacent surface of the sclera is covered with the bulbar portion. The palpebral is firmly attached over the tarsal plates but is loose and movable elsewhere upon the lid. The bulbar conjunctiva continues uninterrupted with the palpebral part along the conjunctival fornices and is freely movable at the borders but is quite loosely attached to the sclera.

Blood which has collected within the orbit, usually resulting from fractures of

the anterior cranial fossa is noticed first under the conjunctiva of the globe near the corneal border. Later it may reach under the upper eyelid and emerge upward beneath the skin. The palpebral fissure is formed by the eyelids between the inner and outer canthus, they unite, at the inner canthus, the lacus lacrimalis in which lies the caruncle which appears as an oval elevation, and the plica semilunaris, which appears on the outer side of the caruncle as a vertical crescentic fold and designates the end of the bulbar conjunctiva (Flessel).

ANESTHESIA IN EYE OPERATIONS

Local anesthesia is used for most operations upon the eye.

Some operations such as for enucleation of the eyeball, acute glaucoma, etc. often call for general anesthesia. Voluntary movement of the eye under local anesthesia is of great aid to the surgeon. Butyn, 2 per cent, instilled into the conjunctival sac is excellent. Such an instillation is made every five minutes. To accomplish complete anesthesia, from six to eight instillations are required. Butyn does not cause drying of the corneal epithelium or produce dilatation of the pupil as does cocaine. (Other anesthetics that may be used are cocaine, novocaine, eucaine, stovaine, alypin etc.). These are sufficient for intraocular operations such as cataract, corneoscleral trephine and operations on the cornea and conjunctiva.

In operations on the eyelids a solution of one to one hundred of novocaine or procaine crystals injected along the orbital margin of the lids is effective. In operations on the extraocular muscles a similar solution, to which a few drops of adrenalin are added, injected subconjunctivally will answer the purpose well.

REMOVAL OF FOREIGN BODIES FROM THE EYE

Conjunctiva

The eye is anesthetized with a freshly made solution of butyn (½ per cent) or holocaine (5 per cent) introduced into the conjunctival sac; wait a few minutes to give the anesthetic an opportunity to act. Occasionally there is no foreign body but simply an abrasion of the corneal epithelium. Pain and lacrimation are, in these cases, usually marked. A drop of 2 per cent fluorescein solution introduced into the eye will stain an abraded area of the cornea bright green while the conjunctiva will assume an orange-yellow hue.

A dark room is best for the removal of foreign bodies. Focal rays of light directed on the eye are best for the purpose.

Retract the eyelid. Locate the foreign body. Attempt to wipe it away with piece of absorbent cotton on an applicator. If this fails the point of a needle is used to remove the foreign body.

Cornea

To dislodge foreign bodies from the cornea is often a more difficult task than those in the conjunctiva. Instill butyn (2 per cent). A good oblique light or focal illumination is essential. The patient is seated and the surgeon stands behind him. The lids are held apart with a proper lid-retractor. Use a fine curet or cataract needle to gently dislodge the foreign body. The instrument is kept parallel to the cornea and the head of the patient is kept steadied to avoid movements which may cause inadvertent injury. In more difficult cases, scratch the cornea over the foreign body and divide the cornea from without inward, after which the foreign body is readily removed. Care should be exercised to prevent traumatic

lesion or pushing the foreign body from the cornea into the anterior chamber of the lens.

Some metal particles may be removed with an ordinary magnet. Deeply imbedded foreign bodies of metal are extracted with an electromagnet. (Fig. 395.) If the foreign substance is in the iris, or anterior chamber or the lens, the point of entry must be enlarged and the foreign body extracted with an appropriate forceps. If it is impacted in the iris and the magnet is ineffective, the segment of iris carrying the foreign body should be removed: an iridectomy.

Fig. 395. — [illegible] magnet.

from the lens is difficult. A traumatic cataract is frequently encountered. It should be extracted.

Crystalline Lens

Make an incision in the cornea with a keratome. Introduce a delicate forceps and remove the foreign body.

A magnet inserted in the anterior chamber will often extract metal bodies. The chemistry of the lens being neutral, foreign substances lodged there cause no ill effects and it is often advisable to leave them alone until the lens loses its transparency when it is removed. However iron, steel and copper bodies should be removed at once.

Vitreous, Choroid and Retina

Foreign bodies in the posterior portions of the eye are treated as follows:

Ascertain the exact position of the foreign body (ophthalmoscope, x-ray, Sweet localizer etc.). Its extraction entails operative maneuvers. It should not be attempted in inadequate surroundings or with improper training. If your experience is limited, keep the conjunctiva clean by irrigations, atropine, dressings, etc., until a specialist performs the necessary procedure. The duty of the general surgeon is to avoid infection from entering.

OPERATIONS ON THE CONJUNCTIVA

Pterygium

Pterygium (wing) is a triangular fold of thickened conjunctiva, resulting from exposure to the wind, sun and dust. It is more common on the nasal side of the cornea than on the temporal side, but may appear on both sides. The apex is referred to as the head; a small adjoining part is called the neck; and the wing-like expansion is termed the body. As growth takes place, the head advances from the corneal margin toward the center of the cornea, causing a concave disfigurement and endangering the sight.

The treatment consists in excision or transplantation, and the operation of McReynolds gives the most satisfactory results. Very few recurrences follow the proper performance of this procedure.

(a) The following is the least complex operation for removing a pterygium.

Step 1. The conjunctiva is anesthetized with cocaine or butyn-solution and the neck of the tumor is grasped with a small forceps at the corneal margin. The tumor is detached from the cornea with a pterygium, cataract or some other very sharp knife. (Fig. 396 A.) Great care should be exercised so that

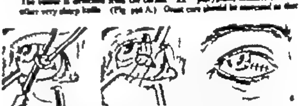


Fig. 396. A. Operation showing pterygium grasped with forceps and detached from cornea with a very sharp knife; B, excision placed; C, suture of the conjunctiva.

the head of the pterygium and all loose tissue is removed without injuring the corneal tissue.

Step 2. The surface of the cornea should be contoured with the actual cautery where the head of the pterygium has been excised. A wedge-shaped piece of the attached conjunctiva is excised with a fine scissors after the head and neck have been detached with a knife.

Step 3. The edges of the wound may be undermined for a short distance before closing. (Figs. 396 B and C.)

(b) When the pterygium is of such size that cutting away its conjunctival pedicle is likely to result in excessive shrinkage of the conjunctiva, the following operation is offered as an alternative. The pterygium, instead of being excised, is transplanted under the conjunctiva a short way from the cornea and healthy, new conjunctiva is brought up to the stripped margin of the cornea. Sliding flaps of many kinds have been offered for use in this procedure.

Benign Tumors of the Conjunctiva

Pinguecula. This is a tiny fatty growth appearing on the conjunctiva; it is about the size of the head of a common pin and of a reddish or yellow hue.

It should be cut away in such a manner that only one suture need be required to unite the edges of the wound.

Lipoma. This condition occurs rather infrequently beneath the conjunctiva. The tumor is shelled out following an incision in the conjunctiva and the edges of the wound sutured.

Angioma. The most successful procedure in this case is complete excision of the angioma by means of a small surgical knife after which the vessels are ligated at the surface. *Galvanocauterization may be instituted as an auxiliary remedy.*

Polypi. These growths are sometimes referred to as pedunculated papillomata and are generally excised, the wound sutured and cauterized with the galvanocautery.

Cysts. These are of [illegible] or dermoid nature. Great care should be exercised when detaching them from the conjunctiva so that they may be completely enveloped [illegible] lifted out. The transparent qualities of cysts [illegible] cause them to be readily blended [illegible] in the conjunctiva. The same procedure is followed as in the case of lipoma. Great care must be taken so that the entire cyst wall is removed in order to prevent its return.

Malignant Tumors of the Conjunctiva

Epithelioma. The margin of the cornea is very often the starting point of primary epithelioma of the conjunctiva. Excision should be promptly prescribed. Electrosurgical destruction or radium gives better results than scalpel surgery.

Malignant Encanthus. This condition is also referred to as epithelioma of the caruncula lacrimalis. The treatment prescribed is thermocoagulation or radium. When an epithelioma of the eyelid or lacrimal passage becomes enlarged it is usually [illegible] as secondary epithelioma of the caruncula and calls for the same treatment as malignant encanthis.

Sarcoma. Melano-sarcoma. This is, generally speaking, a primary tumor of the choroid. Great skill on the part of the surgeon is required in dealing with this serious affection. The treatment is complete enucleation of the eyeball supplemented by thermocoagulation to the remaining structures, followed by radium.

OPERATIONS OF THE EYELIDS

Hordeolum (Stye)

Operation is performed for affection of the glands of Zeis. A local anesthetic solution is injected. Incise the skin parallel with the border of the eyelid. Avoid injury to the tarsus, for such injury may terminate in cysts or chalazions.

Chalazion (Meibomian Cyst, "Kalazeon")

A chalazion is in intimate relationship with the tarsal cartilage. It may become embedded after an incidental inflammatory condition. Its removal may be accomplished through an intermarginal incision, a conjunctival incision, or cutaneous incision.

THE INTERMARGINAL [illegible] INCISION

This method, preferred by many and [illegible], is particularly applicable if the chalazion is situated near the border of the eyelid.

Anesthetize (infiltrate) the eye and affected lid. Make an incision along the margin of the eyelid between the cutaneous and mucous surfaces of the lid. Enter the cyst. Express and curet out its contents and destroy its walls. Apply a compressive dressing. Loss by suture of the conjunctival margin is unnecessary. Avoid hematoma formation.

THE CONJUNCTIVAL ROUTE

Step [illegible]. Grasp the eyelid with a chalazion forceps, placing the spatula blade over the chalazion on the skin side. Evert the lid by a simple rotation of the handle of the forceps. Make an incision in the conjunctiva either perpendicular to or parallel with the lid margin (Fig. 307). (If a parallel incision is

Fig. 307 Fig. 308

Fig. 307. Extirpation of a chalazion by the conjunctival route. Locate the eyelid with Desmarres' forceps, the spatula of which supports the cutaneous surface.

Fig. 308. [illegible] of a chalazion by the cutaneous route. The spatula of the Desmarres forceps [illegible] into the superior conjunctival cul-de-sac.

made it should not extend beyond the limits of the chalazion to prevent the destruction of adjacent meibomian glands.) This incision should extend through the chalazion.

Step 2. The contents can now be removed and the cyst wall completely disrupted with a chalazion curet. It is unnecessary to suture the wound edges with sutures. The space where the chalazion was removed will immediately fill with blood, but this will soon resorb.

THE CUTANEOUS ROUTE

Extensive size of the chalazion calls for this method. Inject the anesthetizing solution. Make an incision running parallel with the margin of the lid extending down to the chalazion (Fig. 308). Dissect it out of its bed. Curet the bed, if necessary. Arrest hemorrhage. Unite the wound edges of the skin with a few interrupted Pagenstecher horn sutures.

Blepharospasm

FUNCTIONAL

This is occasioned by contractions of the orbicularis palpebrarum muscle. It may be a purely reflex manifestation (conjunctivitis, acute or chronic). The treatment is removal of the cause. Partial resection of the orbicularis has been

recommended by some. Where narrowing of the palpebral fissure resulted, external canthoplasty (which see) is indicated.

ESSENTIAL

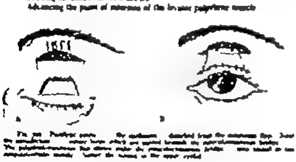
This consists of tonic and clonic contractions of the orbicularis muscle such as is observed in tic douloureux. Treatment consists of resection of the infra-orbital nerve or, if this fails, subsequent resection of the ophthalmic branch of the trigeminus.

Blepharoptosis (Drooping of the Eyelids)

Paresis of the levator muscles through affection of the nerve supplying the muscle caused by an underdevelopment of the levator muscle or paralysis. Mechanical ptosis is due to dragging down of the upper lid (tumors, trachoma). The following procedures are used to correct the condition, though success is not always attained:

Excising the skin to shorten the lid.

Advancing the point of insertion of the levator palpebrae muscle.



A B

Fig. 309. Panas' operation. [illegible] the eyebrow, [illegible] detached from the cutaneous flap, [illegible] [illegible] which are applied beneath the [illegible]. The palpebro-cutaneous flap drawn under the [illegible] bridge [illegible] the [illegible] muscle [illegible] the wound in the upper eyelid.

3. Substituting the action of the frontalis muscle for that of the levator palpebrae superioris.

Combining the two methods just mentioned.

3. Substituting the action of the superior rectus muscle for that of the levator palpebrae.

[illegible] OF A CUTANEOUS FLAP INTO THE UPPER EYELID TO THE [illegible]

Step [illegible]. Fix the eyelid on the tarsus. Dissect from its upper surface a quadrilateral flap with its base directed downward. Detach the cutaneous surface down to the tarsal cartilage (Fig. 309 A).

Step [illegible]. Make a horizontal incision extending along the entire length of the superior border of the eyelid exposing the fibers of the frontalis and corrugator supercilia muscles.

Step 3. Mobilize the bridge of skin between the two openings. The quadrilateral flap now denuded of skin is sutured to the muscle as shown in the illustration.

Step 4. Unite the edges of the upper and lower cutaneous wounds with interrupted sutures (Fig. 309 B).

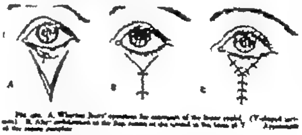
Chalazion removes a rectangular-shaped piece of tarsus ([illegible] to 5 mm. long and [illegible] to 3 mm. wide) together with the conjunctiva. The wound is closed with [illegible] sutures of [illegible] thread and placement of two sutures of finer thread on either side of it. [illegible] lateral stitches are then introduced.

Cicatricial Ectropion

[illegible] [illegible] OPERATION

Step [illegible]. Make a V-shaped flap, preserving its size by the everted lid, including the scar tissue (Fig. 310 A).

Step 2. Extend the convergent incisions downward forming a Y-shaped flap which is dissected up in its lower part.



A B C

Fig. 310. A, Wharton Jones' operation for ectropion of the lower eyelid. (V-shaped incision.) B, After mobilization of the flap suture of the wound in the form of Y. [illegible] Appearance of the suture complete.

Step 3. Suture the lower part vertically in such a manner that the tension upon the ectropion is relieved (Fig. 310 B).

Step [illegible]. Suture the upper parts of the margins to those of the V-shaped flap which has been drawn back (Fig. 310 C).

Atonic Ectropion

[illegible] OPERATION

Step 1. This consists of tracing and excising a small triangle, the base of which is directed upward forming an outward prolongation of the external commissure (Fig. 311 A).

Step 2. Resect the [illegible] portion of the free margin of the lower eyelid.

Step 3. Reunite the edges of the denuded [illegible] surface as shown in the illustration (Fig. 311 B).

Step 4. Repair the conjunctiva and skin.

Entropion

Entropion is an inversion of an eyelid. The eyelashes are turned toward the eyeball. The condition is frequently associated with trachoma.

Canthotomy

This is performed under local anesthesia, the object being to make the palpebral opening larger.

Make a horizontal incision with one blade of a pair of blunt pointed scissors inserted in the conjunctival sac and divide the canthal ligament and conjunctiva simultaneously. The wound may or may not be sutured.

FIG. [illegible] [illegible] operation for [illegible].

Canthoplasty

Step 1. Incise the external commissure horizontally from within outward for about 10 to 15 mm. dividing the skin, orbicularis oculi muscle and soft tissues, to the bone (Fig. [illegible] A).

Step [illegible]. Undermine the conjunctiva at the external angle of the incision (Fig. [illegible] B).

Step 3. Unite by interrupted sutures of the conjunctiva to the respective upper and lower cutaneous wound (Fig. [illegible] C).

Tarsorrhaphy and blepharorrhaphy are synonymous terms designating the shortening or complete closing of the palpebral fissure which may be partial or total, temporary or permanent.

FIG. [illegible] A. External [illegible]. The [illegible] [illegible]. B. [illegible] of the [illegible]. C. [illegible] completed.

Comment. Total tarsorrhaphy is objectionable because of retention of secretions of the eye and because of the difficulty of inspecting the external condition. Median tarsorrhaphy is more adequate.

Ankyloblepharon signifies partial or complete junction of the eyelids. It may be congenital or acquired.

Symblepharon is an adhesive process between the conjunctiva of the eyeball with that of the eyelid.

Blepharoplasty

This signifies repair of defects of the eyelids. For total blepharoplasty the integrity of the conjunctiva and the fibro-cartilaginous framework of the eyelids is [illegible]. Four methods are applicable

1. French Method (sliding flaps).
2. Indian Method (pedicled flaps transposed by torsion or rotation).
3. Italian Method (pedicled flaps from distant parts—arm).
4. Grafting.

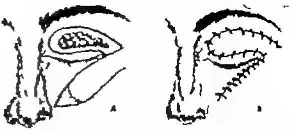


FIG. [illegible] A. Extirpation of [illegible] or [illegible] from the upper eyelid. B. Transfer the flap into the new position. [illegible] in place. [illegible] the [illegible] by approximating the borders of the cutaneous wound.

BLEPHAROPLASTY OF THE UPPER EYELID

Step 1. Dissect out the [illegible] including the surrounding margins (Fig. [illegible] A).

Step 2. Mobilize the autoplastic flap.

Step 3. Suture the flap after shaping it, into its proper place (Fig. [illegible] B).

Step 4. Repair the bed whence the flap was taken. Dress the wound.

FIG. [illegible] A. Extirpation of [illegible] from the lower eyelid. A sliding flap [illegible] and B. Operation completed.

BLEPHAROPLASTY OF THE LOWER EYELID

Step 1. Make a [illegible]-shaped incision around the defect; remove it (Fig. [illegible] A).

Step 2. Make a second [illegible] incision beginning at the same point as the first, thus outlining a flap which is sutured into the bed left by the excised and [illegible] defect (Fig. [illegible] B).

Operations for Symblepharon

Symblepharon signifies scar formation between the conjunctiva of the eyeball and the conjunctiva of the eyelid. Partial symblepharon are characterized by adhesions consisting of single cords while complete symblepharon consists of adhesions of broad bands which have been known to completely obliterate the cul de sac.

Arlt's procedure which is indicated when not more than [illegible] third of the eye is affected, [illegible] performed under [illegible] analgesia.

Step [illegible]. The adhesions may be seized with a forceps or [illegible] may be used. The apex of the symblepharon [illegible] severed from the cornea with sharp knife, the remainder with [illegible] blunt curved scissors.

Step 2. The scar-tissue is dissected from the symblepharon by two incisions reaching from the apex to the base. The flap which results [illegible] placed in the [illegible] which [illegible] left after excising the symblepharon.

Step 3. For [illegible] purposes, the borders of the conjunctival wound are undercut and sutured.

Operations for Trachoma

Trachoma is a condition characterized by chronic conjunctivitis accompanied by an abnormal increase in the size of the conjunctiva and follicular formation.

[illegible]

General anesthesia should be used.

Step [illegible]. Evert the edge of the upper eyelid, grasp [illegible] with the Knapp roller forceps (Fig. [illegible]) and pull the lid upward, exposing the fornix.

Step 2. Insert one cylinder of the roller forceps into the upper fornix while the other cylinder is made to roll over the tarsal region of the conjunctiva.

Step 3. Press the blades of the instrument together causing the cylinder to exert pressure in expressing or "milking" out the secretions and granules. This procedure may be repeated several times until the conjunctiva [illegible] smooth; the procedure is practiced also on the conjunctiva of the lower eyelid. Following the operation, apply cold compresses. When the [illegible] has ceased, apply [illegible] per cent silver nitrate solution daily.

PARTIAL EXCISION OF THE TARSUS AND CONJUNCTIVA [illegible]

The clamp used in this operation resembles that of [illegible] (Fig. [illegible]). It consists of a [illegible] plate upon which descends a [illegible] of five prongs which fit into [illegible] when the instrument is closed.

Step 1. Lift up the middle of the eyelid with the fingers or forceps. Introduce the right prong of the instrument under the lid followed by the left; secure the lock on the lid by means of the ratchet. Reverse the clamp, thus exposing the conjunctival surface of the lid. The curve of the prongs serves as a guide for the incision. Because of tension, the tarsus when incised springs away from the subjacent tissue.

Step [illegible]. In order to leave the [illegible] [illegible] the conjunctiva is sutured to the lid, the tarsus and conjunctiva over it are dissected up and the conjunctiva of the fornix is loosened. The sutures should be about ten inches long, double-armed, and inserted parallel to the inferior margin of the tarsus, the middle stitches being inserted first. [illegible] the sutures above the suture line, remove the clamp and continue the suturing.

No blood is lost during this operation and it may be performed in a short time (10 or 15 minutes). It differs from other methods in that the middle sutures

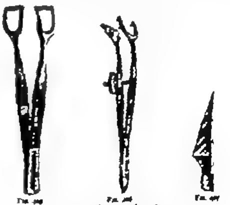


FIG. [illegible] FIG. [illegible] FIG. [illegible]

FIG. [illegible] Knapp trachoma forceps.
FIG. [illegible] [illegible] clamp for removal of tissue in the [illegible].
FIG. [illegible] Burr [illegible].

are placed at a greater distance from the ciliary line, thus securing a deeper furrow and avoiding tucking of the lid in the center.

Operation for Pannus: Peritomy

This operation consists of excising the conjunctiva all around and very close to the cornea, after which the area is cauterized with [illegible] of [illegible]. The vessels on the cornea are scarified by means of a Burr knife (Fig. [illegible]).

Peritomy

[illegible] modification of the above procedure and consists of loosening the conjunctiva all around the cornea as near the limbus as possible; the larger vessels, if exposed, are seared with a hot electrode after which the eye is cleansed with hot boric-acid solution and dressed. These operations are indicated where superficial ulcers or corneal vascularity exist (trachomatous pannus, etc.)

Operations for Removal of the Lacrimal Gland

EXCISION OF THE PALPEBRAL PORTION OF LACRIMAL GLAND

Cocaine anesthesia.

Step 1. Evert the upper lid and draw same up forcibly with forceps. Have the patient look down; the gland can now be seen. Apply a pledget of cotton saturated with solution of adrenalin (1:1000) for minute or so.

Step 2. Make an incision over the gland (Fig. 248 A). Hold the wound open with forceps or strabismus hook. Free the gland by blunt dissection, first above, then below (Fig. 248 B). After the lobes are well dissected out, draw the gland down and cut it off with scissors from the nasal side out. Control hemorrhage by clamping, styptics or pressure.

FIG. 248. A. Incision of palpebral portion of lacrimal gland. Conjunctival incision. B. Dissection of gland almost completed.

EXCISION OF THE ORBITAL OR SUPERIOR LACRIMAL GLAND

It has been shown that if conditions necessitate the removal of the orbital or superior lacrimal gland for such conditions as cysts, epiphora or fistula, the remaining glands of the eye (Krause's, accessories, etc.) are sufficiently capable of lubricating the eyeball.

General anesthesia. Shave the eyebrow.

Step 1. Make curved incision parallel to the outer half of the orbital border through the skin and subcutaneous tissues down to the periosteum. Do not carry the incision too far forward medially.

Step 2. Expose the lacrimal gland by drawing the edges of the wound apart. Grasp the gland with appropriate forceps and remove it by blunt dissection and delicate scissors.

Step 3. Ligate the lacrimal artery. Suture the tarso-orbital fascia with catgut.

Step 4. Close the skin with Pagenstecher linen.

Probing the Lacrimo-Nasal Duct

In the presence of stricture of the canaliculus or nasal duct, an attempt at dilatation with probe introduced into the canaliculus and nasal duct may be followed by success (Fig. 249). To eliminate the pain incident to the procedure few drops of novocaine solution are instilled into the culdesac and lacrimal sac. In probing, caution should be exercised not to penetrate the lacrimal bone or the wall of the sac or duct during the manipulations.

Incising Canaliculus or Lacrimal Duct

This procedure is indicated in some form of stricture, displaced puncta lacrimalis and dacryocystitis. It is contraindicated as a preliminary procedure to probing the lacrimal duct unless absolutely necessary. Its benefits are temporary. Gas or local anesthesia should be used. Weber's or Agnew's canaliculus knife is well adapted for the purpose.

Step 1. Evert the lower eyelid.

Step 2. Introduce the knife into the punctum in a vertical direction. (Fig. 250 A.) Put the lid on the stretch away from the inside angle and hold in slight eversion. Introduce the knife in such a manner that its cutting edge is directed upward and backward so that the incision will come in contact with the conjunctiva of the globe when the lid is released. Be sure that the end of the knife is in contact with the conjunctiva of the globe when the lid is released; also that the end of the knife is in contact with the interior of the nasal wall of the sac—then the incision should be made. (Fig. 250 B.)

Step 3. After the incision is made introduce a probe of appropriate size and leave it there for a few minutes.

Dilate the channel for four or five days and continue catheterization for as long as is deemed necessary. (Fig. 250 C.) Incisions may be made in other directions and into the nasal duct as shown in the illustrations. (Fig. 250 D.)

FIG. 250. Introduction of canal[illegible] into the inferior lacrimal punctum.

Note. The canaliculus should never be cut unless it cannot be opened by means of blunt probes; cutting renders it functionless.

Extirpation of the Lacrimal Sac

Anesthesia. General or local. The superficial injection of the analgesic solution is made under the skin along the anterior crest of the lacrimal groove. The deep injection into the tissues is made by introducing the hypodermic needle 1 mm. above the inner canthus and carrying the point of the needle straight back to the tissues above the dome of the sac. In usual cases the needle should be inserted about 6 mm. (¼ in.) entering the skin at a point where the lower border of the orbit and the upper anterior portion of the lacrimal bone join, and following downward, backward and inward path to penetrate the neck of the lacrimal sac. When the anesthetizing solution is forced into the sac it generally causes the fluid already in the cavity to enter the canaliculus along with the anesthetic. Further injections are unnecessary as the solution already injected is sufficient to block

and anesthetize the canaliculi, the mouth of the nasal duct, the sac wall and adjacent tissues.

Step 1. Make the incision along the entire length of the anterior crest of the lacrimal groove beginning at a point 3 mm. above the canthal ligament and 3 mm. to the nasal side of the inner canthus and ending at the mouth of the duct.

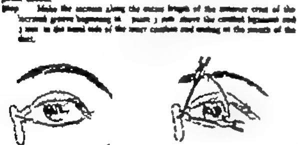


FIG. 251. A. Inserting canaliculus or lacrimal duct [illegible]. B. Weber's knife has been introduced [illegible]. Appearance of completed incision of [illegible].

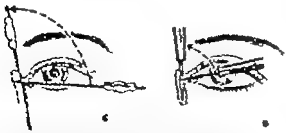


FIG. 252. [illegible]

Step 2. With tooth forceps and scissors detach the skin from the canthal ligament and the adjoining orbicularis muscle. Introduce Muller's speculum.

Step 3. Expose the canthal ligament by making an incision parallel to its fibers on the upper and lower borders.

Step 4. Incise the canthal ligament backward and inward about 1 mm. from its bony attachment; separate the orbicularis fibers along the anterior crest, from the upper to the lower end of the first incision. The deep fascia around the lacrimal sac is thus exposed.

Step 5. Incise the deep fascia behind the stump of the canthal ligament exposing the front wall of the lacrimal sac which is more flabby and of a different color than the tough fascia surrounding it.

Step 6. Separate the fascia along the anterior crest of the lacrimal groove. (The incisions in the orbicularis muscle and the deep fascia should lie immediately behind the first incision and be of the same length; complete exposure of the sac facilitates enucleation.)

Step 7. Dissect the deep fascia from the sac-wall with mouse-tooth forceps and scissors; extend the dissection to the posterior crest of the lacrimal groove.

Step 8. Dissect the sac from the periosteum with the aid of forceps and scissors and extend the dissection from the dome of the sac to the mouth of the duct. After cutting the connective tissues at the dome and grasping the upper part of the sac wall, drawing it gently out of its bed, the adhesions along the posterior crest are divided with scissors.

Step 9. While drawing the sac upward, the mouth of the duct is divided with scissors as far down as possible. Curetting and probing are unnecessary if the sac has been entirely removed. Irrigate with boric acid solution or swab with weak tincture of iodine.

Step 10. With fine catgut, suture first the ligament, then the skin so that the temporal flap is slightly elevated to prevent ectropion and ptosis of the lower lid which is likely to follow.

Comments. The Toti-Mosher operation for chronic dacryocystitis consists of approaching the lacrimal sac through an external incision and creating communication between the sac and nasal cavity. This can also be accomplished by West's operation, the approach being from the inside of the nose.

OPERATIONS ON THE CORNEA

Wounds of the Cornea

Ordinary wounds without prolapse of the iris require no suture. In prolapse of the iris, snip off the incarcerated portion. Apply dressings after closing the lid. Suture of the sclera is accomplished with fine curved needle and no catgut. The sutures are interrupted and tied lightly. Do not pass the needle through the entire thickness of the sclera—only the conjunctiva and superficial layers of the sclera are sutured. In injury to the posterior chamber Lejars recommends using needle on each end of the catgut suture, both entering the wound from within outward. Good guarded prognosis.

Paracentesis of the Cornea

Retract the lids with speculum. Steady the eye. Insert a von Graefe knife or paracentesis needle at the lower end of the vertical meridian of the cornea; the instrument is withdrawn slowly as soon as it enters the anterior chamber of the eye. If necessary, the iris is replaced and the eye dressed.

Guthrie-Saemisch's Operation for Corneal Ulcer

KERATOTOMY

This operation is performed to avoid destruction of the cornea. Steady the eye with fixation forceps. Hold the lids apart with speculum. Insert a Graefe knife on the temporal surface of the horizontal meridian of the cornea.

drawing it outward it will divide the ulcer Remove all affected tissue Irrigate the eye with warm salt-solution Dress Serious postoperative complications sometimes follow this procedure It is performed only in the hope of saving an eye that might otherwise be lost

KERATECTOMY

KRAPF'S OPERATION FOR STAPHYLOMA

Bulging of the cornea is often occasioned by penetrating (knife) injuries, ophthalmia neonatorum, etc and results in total blindness.

Step 1. Place mattress-like suture on the nasal side of the vertical meridian and another on the temporal side of the eye

Step 2. Steady the eye with fixation forceps Introduce Beer knife at the temporal end of the horizontal meridian hold flat and carry it downward

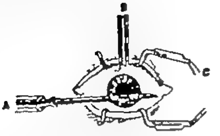


Fig. 41 Paracentesis of the anterior chamber A, von Graefe's knife puncturing the lower part of the anterior chamber fixation forceps, C, lid retractor

and outward along the base of the staphyloma until half of it is dissected grasp the detached part with mouse-tooth forceps, draw it upward and divide it with scissors along its upper attachment in accordance with the direction made below The lens and vitreous may not always be saved.

Step 3 Tie the mattress-like sutures

This operation is performed principally for esthetic reasons The surgeon has the choice of removing the eye or excision of the staphyloma Beer recommends leaving the wound open and the eye dressed

Transplantation of the Cornea

The transplant is usually obtained from an eye that has just been removed Many of these corneas unite with the surrounding structures satisfactorily However the ultimate result is not very satisfactory the transplant often loses its transparency This operation should be attempted only by a specialist well versed in corneal transplantation

In partial keratoplasty the Descemet membrane and the posterior transparent layer of the cornea are omitted In total keratoplasty the entire thickness of the cornea is used

OPERATIONS ON THE SCLERA

Paracentesis of the Sclera

This is indicated in detachment of the retina the subretinal fluid is withdrawn

Step 1. Anesthetize the eye draw back the eyelid and steady the eyeball with fixation forceps draw a portion of the conjunctiva to one side with forceps and see to it that the puncture point will not be made directly over that in the sclera (Fig 41)

Step Insert a von Graefe knife into the sclera and channel withdrawing so that the scleral fibers are separated.

Fig. 410 Fig. 411

Fig. 410. Suturing wound of the sclera Note that two needles are used. Observe that one end of the suture has just passed through the conjunctiva and outer layer of the sclera from within outward.

Fig. 411. Anterior sclerotomy. The von Graefe knife is pointed in such a manner as to leave a superficial sclerotic bridge.

Step 3. Insert a cataract knife in the posterior vitreous, observing care so as not to injure the retina raise the conjunctiva slightly permitting the retinal fluid to escape Instill atropine drop the eyes and permit the patient to remain in bed for several days

Wounds of the Sclera

Wounds of the sclera are repaired by suture as shown in Fig 410

Anterior Sclerotomy

This operation is performed to relieve tension within the eye A filtering scar is created in the anterior chamber of the eye which will permit the escape of aqueous humor

Step Use a narrow bladed von Graefe knife With its edge directed upward, penetrate at a point 1 mm outside the margin of the superior-external quadrant of the cornea entering the anterior chamber and emerging at a point directly opposite the point of entrance (Fig 411).

Step With saw-saw motion of the knife, the superior sclero-corneal bridge is incompletely divided leaving a thin lamella of the sclera at its middle

Posterior Sclerotomy

In this operation the vitreous space is punctured through the sclera. Often, iridectomy is performed immediately following this operation which is rendered much easier due to the softer globe resulting from the escape of vitreous The benefit derived from this operation is only temporary

Sclerotomy and Sclerecto-Iridectomy

Sclerectomy is occasionally indicated where the tension is increased at intervals, caused by chronic glaucoma sclerecto-iridectomy is used in instances of chronic glaucoma where the increased tension is constant. A partially closed incision is made with the object of creating a cystoid filtering cicatrix, thus diminishing tension. Sclerectomy consists of excision of part of the sclera In sclerecto-iridectomy sclerectomy is followed by an iridectomy

Trephining of the Sclera

This is used in glaucoma and is accomplished by inserting a trephine on the limbus, creating an aperture in the sclero-corneal line for filtration purposes

OPERATIONS ON THE IRIS

Injury to the Iris

The iris is rarely injured without injury to the crystalline lens A hernia of the iris through the corneal wound usually results If there is no inflammation, an attempt should be made to replace the iris resection of the protruding iris is usually done

Iridectomy

Local or general anesthesia may be used The procedure consists of incising the anterior chamber of the eye, usually through the sclera but occasionally through the cornea (Fig 414A) the iris is grasped with forceps which is introduced through this opening, drawn out and severed (Fig 414B, C, and D).

This operation is done for the purpose of forming an artificial pupil, for diminishing intra-ocular tension and as an accessory to the operation for cataract.

In adhesions of the iris an attempt may be made to destroy these with the help of a properly constructed instrument introduced through a small incision in the cornea. This, however is usually unsuccessful

Iridotomy

Insert scissors through an incision in the cornea, one blade entering in front, the other behind the iris. The blades of the scissors are brought together dividing the lower peripheral side opposite the cornea

Extraction of the Crystalline Lens for Cataract

An opacity of the crystalline lens is spoken of as cataract. Structurally, three kinds of cataract are recognized, (a) lenticular (b) capsular and (c) capsulo-lenticular They may be either primary or secondary They are referred

to according to their density as soft, hard and fluid. There may be either complete or partial covering of the lens. The condition may be stationary or progressive

In extracting the lens affected in cataract a linear incision is made with keratome or a flap incision is made with a Graefe knife In the case of simple extraction, the lens is removed without removing the iris. In other instances a portion of the iris is removed with the lens. The combined procedure is used more

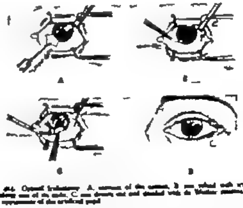


Fig. 414. Optical Iridectomy A, incision of the cornea, B, iris seized with iridectomy forceps drawn out of its angle, C, iris drawn out and divided with de Wecker scissors, D, postoperative appearance of the artificial pupil

often however it is a matter of choice and judgment to be decided in individual cases

ASPIRATION FOR SOFT CATARACT

Soft, non-nucleate cataracts of young subjects and recent traumatic cataracts may be evacuated by aspiration. Use a hypodermic syringe having a needle about 1 mm in caliber Plunge it into the crystalline lens, the needle taking an oblique direction.

Simple Extraction of the Lens for Cataract in its Capsule

EXTRACAPSULAR EXTRACTION FOR SENILE CATARACT

A preliminary iridectomy as described above may be done some weeks or months before the cataract is removed. Preliminary resection of the iris (sibic tomy) simplifies the procedure

Step 1. Cocaine analgesia. Introduce an eye speculum. Fix the eye with proper forceps Grasp the conjunctiva below the transverse diameter of the cornea. Ask the patient to look downward. Introduce a v. Graefe knife at the junction of the cornea with the sclera. Pass it horizontally across the anterior chamber of the eye and allow it to emerge at an exact point opposite that it entered—

a flap is thus produced as shown in the illustration (Fig. 4 5A). At this juncture aqueous humor escapes and often luxation of the iris takes place.

Step 2. An adequate sharp pointed instrument is introduced, taking care while so doing that no injury is inflicted to the iris, and the capsule of the cataract is torn open. When this is effectually accomplished the lens projects into the anterior chamber. Remove the forceps. Hold steady the eye (Fig. 4 5B).

Step 3. This step consists in extracting the lens. Have the patient look downward. Depress the upper lip of the incision with the curet (Fig. 4 5C) while pressure is being exerted with blunt instrument from below upwards, thus the lens is dislodged. Should difficulties in dislodging the lens be encountered at this stage of the operation proceed to an iridectomy. When the lens has been removed, take away the retractor. Have the patient close the eye.

Step 4. If there be remaining cortical fragments, express these gently into the anterior chamber of the eye by friction on the lower segment of the globe whence they are brought out with appropriate forceps.

Fig. 4 5. Operations for cataract. A. Extraction by small superior flap. Incision of the cornea. B. Incision of the capsule with cystotome. C. Extraction of the crystalline lens. The upper lip of the incision depressed with blunt curet, while the forceps press from below upwards for expulsion of the lens.

Step 5. Reduce the iris with spatula. Dryin, at this stage of the operation, instruct the patient to close the eyelid gently. A tampon of cotton is soaked in ice-cold boric acid solution and applied to the closed lid. This is to produce prompt contraction of the iris and to diminish the risk of "entanglement of the wound." Before applying the cold tampon, warn the patient to remain perfectly still to frustrate brusque movements of the eyelid.

Step 6. Instill one ointment salicylate into the conjunctival sac. See that the corneal flap is properly coapted. Delicate squares of fine absorbing gauze soaked in boric acid solution are applied over the closed eyelid; over this place an oil-silk dressing and over all voluminous dressing. The opposite eye is also permitted to remain covered with bandage applied prior to the operation.

Comment. Change the dressings in dark room when called for—usually about the fourth day. Boric acid dressings are used the following day. The patient should remain in darkened room until all conjunctival irritation has receded. He should wear smoked glasses and avoid winds and drafts. Proper glasses should be fitted after 6 or 8 weeks.

Operative Accidents

(a) Wounds of the iris, if small, need be of no concern.

(b) Luxation of the lens into the vitreous demands immediate iridectomy and removal of the lens. If the quantity of escaped vitreous is one third of its total, the condition is not considered irremediable.

(c) Locking of the iris should be remedied by correcting it at the first dressing.

Intracapsular Extractions

EXPRESSION OR SMITH INDIAN METHOD

Corneal Incision. Iridectomy. Pressure on lower limbus with Smith expression hook dislocates the lens by breaking the zonular fibers. If the fibers of the

Fig. 4 6. Intracapsular extraction. Lower edge is presented first due to breaking of zonular fibers. ( )

zonule break at the top of the lens near the incision the lens will be delivered in the upright position but if the zonular fibers below break first, the lens will turn over and the lower edge of the lens will present first (Fig. 4 6). The latter is the best method.

TRACTION METHOD

Forceps Operation. The lens capsule is grasped with toothless forceps and by gentle traction the lens is extracted from the eye (Fig. 4 7A and B).

Vacuum Operation. A vacuum cup is placed over the anterior capsule of the lens; vacuum is created by means of vacuum pump (being connected to the cup by means of rubber hose) and the cataract is extracted by gentle pull of the cup either lifting the lens out of the eye in the upright position or by tumbling.

Combined Traction and Expression Method. This method is employed to the best advantage. Either the capsule forceps or the vacuum cup is used for traction and a Smith hook or Kuhnt's sciatic forceps is used for expression (Fig. 4 8).

OPERATIONS ON THE OCULAR MUSCLES

These operations have for their object to increase, decrease or modify muscle-function. If an increase is desired the muscle is shortened or advanced. If decrease, it is set back either by tenotomy or recession. Lateral displacement of the muscle insertions is used to correct any defect regarding the direction of the muscle-pull.

Strabismus (squint) may be either convergent or divergent depending in which direction the eyeball turns—in or out; the former is usually the more common type particularly in children. The underlying principles for the correction of strabismus rests on the (a) weakening of the rectus muscle by tenotomy; (b)

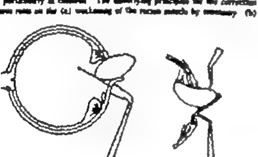


Fig. 4 7A. Fig. 4 7B.

Fig. 4 7. The lens capsule grasped with toothless forceps and gently extracted from the eye (after Knapp). Fig. 4 8. Same as tumbling.

by strengthening an opposing muscle by advancement of its insertion or resection of portion of the muscle.

In advancement the tendon divided and its insertion carried forward from its normal position toward the cornea. Numerous methods have been described—the aim of all advancement operations to increase the power of comparatively weak muscle.

Internal (Open Method)

TENOTOMY OF THE RECTUS MUSCLE OPEN METHOD

Step 1. Expose the muscle to be divided through an incision in the conjunctiva made with strabismus scissors (Fig. 4 9).

Step 2. Expose the margin of the muscle by blunt dissection.

Step 3. With the aid of strabismus hook draw out the muscle and sever it with scissors between the hook and insertion of the muscle (Fig. 4 0A and B).

Irrigate the eye with boric-acid solution and examine it to determine the degree of correction accomplished. If under-corrected expose other muscle fibers

with the strabismus hook and divide them. If over-corrected insert suture into Tenon's capsule, the muscle and the episcleral tissues thus shortening the muscle slightly. When the desired correction is accomplished the wound is sutured and the eye dressed.

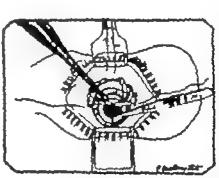
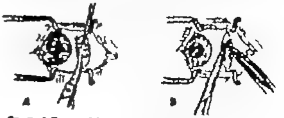


Fig. 4 8.

Fig. 4 9.

Fig. 4 8. The forceps being used in an operation maintained to aid in the delivery of the lens. Fig. 4 9. Strabismus scissors and pointed forceps scissors.

This operation is superior to subconjunctival tenotomy. Hemorrhage is checked by the adrenalin contained in the anesthetic solution. Use dull-pointed



A B

Fig. 4 0. A. Tenotomy of the tendon of the internal rectus muscle; the tendon of the internal rectus muscle is raised on blunt hook. Division of the subconjunctival operation. B. Completion of operation.

scissors in dividing the tendon in order to avoid injury to the sclera. Do-
reuniting end of the severed muscle to the sclera if it draws
eyeball may protrude from Tenon capsule if incised too freely.

EXTERNAL RECTUS

Tenotomy of the external rectus is done in the same manner only it is slightly less difficult. The same procedure may also be applied to the superior and inferior recti muscles, but in this instance the procedure is more difficult (Fig. 4[illegible] A, B and C).

Recession Operation with Control-Suture

NUGENT'S OPERATION

Nugent has devised an operation for use in almost every type of strabismus, in which a control suture is used giving the operator a chance to readjust the muscle on the second or third postoperative days. This provides a means of securing better results in a larger percentage of cases.

Cocaine or novocaine anesthesia (Figs. 422A and B).

A B C

FIG. 4[illegible]. Muscular advancement of the external rectus muscle. A, [illegible] of the two [illegible] sutures into the conjunctiva and the peripheral end of the [illegible] tendon; B, after the tendon has been divided the sutures are passed through the [illegible] close to the corneal margin; C, the suturing is nearly completed.

Step 1. Make a vertical conjunctival incision 10 mm. long directly over the attachment of the strong muscle (Fig. 422C).

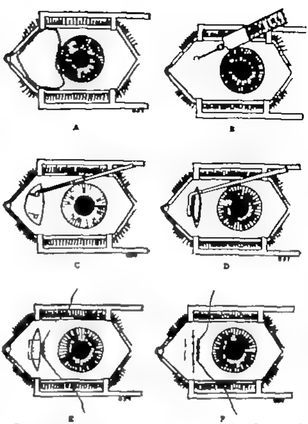
Step 2. Pick up the capsule of Tenon and incise it with scissors just above and below the attachment of the muscle.

Step 3. Pass a strabismus hook under the muscle (Fig. 422D).

Step 4. Secure the muscle in the clamp and cut off the tendon.

Step 5. While the muscle is still in the clamp, place a double armed silk suture through the muscle, capsule of Tenon and conjunctiva, 2 mm. apart near the center of the muscle from behind forward. Pass each needle back through, one at the upper edge and one at the lower edge of the muscle and attach by passing the needles through the cut tendon stump from behind forward including the conjunctiva (Fig. 422E) to form a surgeon's knot.

Note. There should now be an overcorrection. If this does not produce it, there should be some form of advancement operation performed on the opposite muscle. The surgeon's knot is now tightened sufficiently to straighten the eye and the long ends of the suture are fastened on the forehead with a piece of surgeon's adhesive (Fig. 423). The conjunctiva is now sutured (Fig. 422E, F). The capsule of Tenon must be left free. The next day if there is an over- or undercorrection, the surgeon's knot can be tightened or loosened. No eye-patches are used but the patient must wear proper correcting lenses instead.



A B C D E F

FIG. 422. Recession operation with control suture (after Nugent). A and B, [illegible] of speculum and [illegible] [illegible] for [illegible] [illegible] hook [illegible] under muscle. D, Muscle [illegible] by clamp and tendon cut off. [illegible] Suturing of wound. F, Conjunctiva sutured and capsule of Tenon left free.

Enucleation of the Eyeball

This operation consists of completely excising the eyeball from Tenon's capsule and is indicated in cases of malignancy, conditions threatening the sight of the opposite eye and incurable loss of vision accompanied by much pain and in irreparable damage the result of trauma.

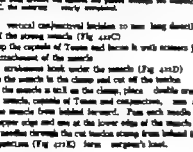


FIG. 423. Recession operation with control suture (after Nugent). Long ends of suture are fastened on the forehead with a piece of surgeon's adhesive.

Step 1. Irrigate the eye with boric acid solution. Instill a few adrenalin for hemostasis. General anesthesia. Introduce appropriate eye speculum. Where the anterior portion of the eyeball is badly lacerated, sew up the wound with silk or linen sutures. Leave the ends of these sutures long; they will act well as a tractor.

A B C

FIG. 424. Enucleation of the eyeball. A, first stage, suture of the [illegible] end of the tendon of the external rectus muscle; B, second stage, division of the optic nerve; C, third stage, luxation of the eyeball.

Step 2. If no traction-sutures are used, grasp the conjunctiva with mouse-tooth forceps, incise it near the cornea with a pair of small curved scissors and dissect it free from the cornea all the way around. Dissect all conjunctival and subconjunctival structures from the globe backward, and expose the insertion of the rectus tendons (Fig. 424A). Pick up the tendons with a strabismus hook and divide them.

Step 3. Force the globe of the eye forward by traction. Pass the blades of the enucleating scissors behind the globe, divide the optic nerve at its ocular extremity (Fig. 424B). This will permit the eye to come freely forward.

Step 4. Dissect and divide the tendons of the superior muscles as close to the sclera as possible. Divide the inferior muscles and conjunctiva below the cornea. Free all further attachments (Fig. 424C).

Step 5. Tampon and arrest all bleeding. Suturing of the conjunctiva is optional. Dress the wound daily until it is healed.

Modified Enucleation Operations. There are a number of variations of this procedure.

(a) Evisceration: this consists of removing the contents of the eyeball and leaving behind the sclera with its connecting muscles.

(b) Operations where, following enucleation, an artificial eye is placed in Tenon's capsule or into the sclera following evisceration.

The introduction of adipose tissue into the cavity after removing the eyeball has been used effectually; the abdomen or thigh usually furnishes the fat. No doubt some of the fat is absorbed, but enough adipose tissue remains for a good stump.

[illegible] METHOD

As each rectus muscle is severed during the process of enucleation, a mattress suture of catgut is placed in each end with the loop outside. A fat-transplant placed in Tenon's capsule, spread so as not to overfill it, the ends of the four recti muscles being brought together over it in the form of a cross. Tenon's capsule is closed over the muscles with catgut-sutures and the conjunctival borders are sutured with silk.

Enucleation of the Eyeball Followed by Insertion of an Artificial Globe Within the Scleral Sac (Mules' Operation)

After the eyeball is removed in the usual manner a hollow globe is placed in the scleral sac and the sclera and conjunctiva are sutured over it. Later (about 10 to 14 days after operation), a cup-shaped artificial eye is placed between the conjunctiva and the eyelids. This must be carefully fitted into the cavity so as not to injure the conjunctiva causing granulations and scar tissue formation. The conjunctiva and lacrimal sac should be scrutinized if the artificial eye causes to cause pain. An infected lacrimal sac should be treated or removed; in cases of inflamed conjunctiva, do not remove the eye until the conjunctivitis is cured. Granulation tissue should be ablated with scissors, followed by cauterization with a lunar caustic pencil. Excessive contraction of scar-tissue sometimes renders the retaining of an artificial eye impossible. This condition usually follows injury to the conjunctiva or an improperly performed enucleation. In cases of complete obliteration of the conjunctival culdesac a new one is formed with skin grafts. The restoration of eye sockets by this method is difficult and not always satisfactory especially if the lower palpebral eyelid is injured or a new upper culdesac has to be made.

CHAPTER 16

SURGERY OF THE NOSE

RHINOPLASTICS

LOCAL ANESTHESIA FOR NOSE OPERATIONS

Shrinking Solution

This is made up of [illegible] per cent of cocaine hydrochloride; to each ounce of this solution is added sixty drops of [illegible] 1000 epinephrine solution. The solution is very potent and must be used with caution.

As a rule the turbinate tissue will shrink down in a few minutes after a small amount has been sprayed into the nostril. This facilitates a thorough examination of the nasal chambers owing to the contraction of the tissues produced by the cocaine-epinephrine.

Block Anesthesia

The points of injection are indicated in Fig. [illegible]

Preparing the Nasal Chambers for Operation with Cocaine

Combine [illegible] drams of 10 per cent solution of cocaine with [illegible] drams of 1:1000 epinephrine. Anesthesia should take place 5 or 10 minutes after this has been applied with cotton pledgets. Two pledgets about 3 inches long and [illegible] inch wide are used for each side of the nose, one inserted as far up in the nose as possible and placed so that [illegible] covers much of the mucosa.

COCAINIZING THE PHARYNX

After instructing the patient not to swallow, spray a small amount of [illegible] 5 per cent cocaine solution into the pharynx, the excess of which is held in the mouth for a few minutes and then expectorated. This is repeated twice within 5 minutes.

COCAINIZATION OF THE LARYNX FOR DIRECT EXAMINATION

First cocainize the pharynx as above. With a laryngeal applicator paint the root of the tongue with a mixture of 20 per cent cocaine and adrenalin. The epiglottis is then covered with the cocaine on the applicator and the applicator passed into each pyriform sinus. This is done with the aid of a laryngeal mirror. Next, the solution is applied to the arytenoids, vocal cords and interior of the larynx by means of the applicator.

LOCAL ANESTHESIA FOR BRONCHOSCOPY AND ESOPHAGOSCOPY

Cocainizing the pharynx suffices in cases of esophagoscopy. The larynx is anesthetized as described above in cases of bronchoscopy. (Important: Always spraying a small amount of 10 per cent solution when the bronchoscope is inserted, just before its beak reaches the carina trachea.) One cc. of [illegible] per cent cocaine is dropped between the vocal cords into the trachea.

Anesthesia is unnecessary for children under five years of age. General anesthesia may be employed for those between the ages of five and fifteen who are difficult to handle.

When frequent examinations of the bronchi and esophagus become necessary patients frequently request that no anesthesia be given.

TAMPON OF NASAL CAVITIES FOR NASAL HEMORRHAGE

In attempting to check bleeding from the nose, simple measures should first be given preference. There are certain dangers connected with nasal tamponade,

Fig. [illegible]. Points of bleeding and areas of [illegible] of [illegible] fluid [illegible] of the nose.

viz. Injury to the intranasal structures, sepsis introduced into the nasal cavities or accessory sinuses, and in some cases into the Eustachian tubes and middle ear.

Determine whether the hemorrhage comes from (a) a capillary or telangiectatic vessel or (b) whether a systemic condition is the causative factor.

Among the simple measures which may be mentioned are a spray of adrenalin solution [illegible] projected into the nostril or applied to the bleeding point with a cotton-covered applicator, a piece of ice pressed against either side of the nose and another piece pressed against the neck. (Hot saline solutions may sometimes check the bleeding.) When the bleeding-point is located, exert direct pressure against it.

When all simple measures fail, tamponade of the nasal cavities is resorted to.

(a) Tamponing the Anterior Nares. Pack the nostril with strips of sterile or medicated gauze (adrenalin, tincture of benzoin compound, etc.) through a nasal speculum. The tampon should be introduced back of the bleeding point, otherwise the oozing will continue into the nasopharynx.

Bernay's compressed cotton sponges are often useful. They are introduced into the nostril and fed sterile saline solution through a medicine dropper until the sponges swell sufficiently to compress the nasal walls and fill the nostril, thus causing the arrest of the bleeding.

Packing the Posterior Nares by Postnasal Tampon

This procedure is done without anesthesia or local application is substituted in the presence of extensive bleeding. Insert a small soft rubber catheter into the nostril. This will be seen in the pharynx, coming down behind the palate. Grasp the end with a hemostat and bring it through the mouth. This is repeated on the other side. A postnasal tampon consists of a roll of gauze or cotton of a size that will fit into the postnasal space. Attached to the center are three linen strings about nine inches long. Two of these are attached to the protruding catheters. (Fig. [illegible] A.) The nasal ends of the catheters are pulled forward, drawing the postnasal tampon into the nasopharynx; the finger is used to wedge the pack firmly into the nasopharyngeal space. The third string is brought out of the mouth and attached loosely to the cheek with adhesive. The purpose of this string is to facilitate the removal of the tampon.

The anterior nares [illegible] then packed with small strips of vaseline gauze, which are placed firmly against the postnasal tampon. (Fig. [illegible] B.) While the anterior packing is being done the strings holding the postnasal tampon should be held taut by an assistant. When the anterior nares is packed sufficiently to control the bleeding, the strings should be tied together, with a small strip of gauze to protect the columella.

The tampon should not be left in place longer than 48 hours, as there is grave danger of causing an acute otitis media or an acute purulent sinusitis. If bleeding occurs upon removing the tampon, fresh one should be inserted.

PLASTIC SURGERY

Historical Notes. Repair of the nose by plastic measures is an ancient procedure. Ancient India and Italy contributed much to its progress. As early as 1442 Branca [illegible] his experiences with plastic procedures. Tagliacozzi, in 1597, paved the way to further endeavors which while dormant for some centuries was revived enthusiastically toward the end of the eighteenth century. Dieffenbach of the nineteenth did much pioneer work in this field. He was first to attempt to substitute, by plastic means, an entire nose. He used only the skin from the forehead or arm to accomplish that end. Contraction of the tissues marred the final result. Two important factors were lacking in Dieffenbach's procedure. First, a lining for the interior of the nose, and second, a support for the regenerated appendage. Efforts to accomplish the first were made by Dieffenbach, Dittrich, von Langenbeck and Lopez. Supports made of metals (gold, platinum and lead) were not satisfactory. Leonard was successful in 1877 in implanting a support made of light metal in [illegible] of [illegible]. The [illegible] of [illegible] to [illegible] flaps of skin and periosteum belongs to von Langenbeck. These were not successful. It was Ollier who, in 186[illegible], supported the skin, periosteal-flap with bone. Following Ollier, Israel, von Langenbeck elaborated the method. König, in 1886, made much progress with his operation by using skin, periosteum and bone-flap taken from the forehead. A host of observers followed with contributions in the decades rolled on; among these the following have [illegible] part: Kausch, Carpue, Bauer, Dubois, Lisa, [illegible], Roberts, Kirchner, Keen, Blandin, Lexer, Joseph, Joseph, Pitts, [illegible], Beck, Roberts, [illegible], Jacques, Keegan, Roe, Kolle, Reverdin, Smith, Kazanjian, Thiersch, Gersuny, Lotze, Carl Beck of New York and many others.

TOTAL RHINOPLASTY

may be divided into the following five surgical groups:

1. The Indian Method (Flap from the Forehead).
2. The French Method (Flap from the Cheek).
3. The Italian (Tagliacotian) Method (Flap from the Arm).

4. The Finger Method.
5. The German Method (Flap from the Chest).

The Indian Method

PRIMARY OPERATION

This procedure is advocated in cases where the nasal cartilages, also septum and columella cannot be saved but in which the bones of the nose and the skin covering them are in sound condition.

Step 1. With a pencil outline a flap on the forehead, the size and shape of which corresponds with the area of tissue to be replaced. In order to avoid including any of the scalp, the flap must be taken diagonally across the forehead, not vertically. The pedicle is attached to the internal angle of the orbit and great care should be exercised that the angular artery which nourishes the flap is not injured. (Fig. [illegible] A.)

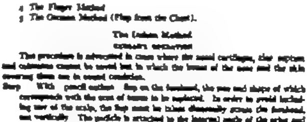


Fig. [illegible]. A. Plugging of nasal fossa for epistaxis. Tampon attached to end of catheter. B. Posterior and anterior tampons in place.

Step 2. Freshen the edges of the defect and prepare the lining of the nose. Make two convergent incisions at a point a little outside the roots of the alae of the nose, extending upward to two points about 1/2 in. apart. A horizontal incision is now made slightly above the border of the defect, from the center of which incision another perpendicular incision is made reaching downward to where the nasal bones are joined by the cartilages. Thus two quadrangular flaps are formed; these are placed in such a position that the nasal cavity is lined by their skin surfaces; the remaining edges of the defect are now freshened. (Fig. [illegible] B.)

It will now be seen that the triangular pieces overlap when the flaps are folded down. Keegan recommends that these pieces be removed and planted into the wound on the forehead. Smith does not cut away pieces but splits the old septum, inserting the edges of the tissue into the wound, in this manner making a septum and columella.

Step 3 The outline incision of the flap is now deepened by cutting down to but not through the periosteum The flap is detached from the forehead and twisted down over the nose with as little manipulation as possible The fact that the bridge has been made oblique, being higher on one side than the other makes the twisting much easier

Step 4 The two raw surfaces now lie apposed Suture together the inferior margins of the quadrangular nasal flaps and the forehead flap The part of the flap fashioned for the purpose is fitted into the former site of the old columella which was previously prepared when the edges of the defect were freshened The two converging incisions made first are now deepened

Fig. [illegible] A [illegible] operation (Indian method) of rhinoplasty Formation of nasal flap [illegible]

and are beveled for the purpose of suturing them to the lateral margins of the flaps

Step 5 Approximate the sides of the wound on the forehead

Step 6 Drainage tubes are inserted into each newly formed nostril and boric acid-ointment dressings applied over the lateral margins of nose and cheek

Step 7 About two weeks after the first operation the pedicle is divided A wedge-shaped segment of tissue taken from the forehead is implanted into the frontal defect

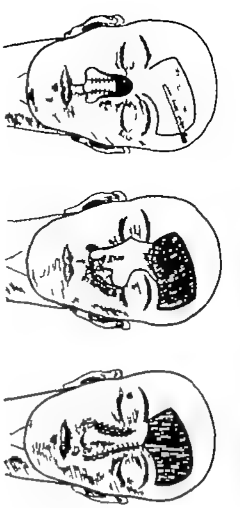
Although this method has been modified and improved upon, it is generally agreed that flat nose results where there are no nasal bones to support the transplanted substance For this reason, pieces of bone and cartilage are transplanted with the flap

[illegible] OPERATION

Stage

Step Expose the entire length of the costal cartilage of the eighth rib

Step Excise the rib and trim down to [illegible] 5 cm. long by 3 mm wide



Step 3 Cut a notch where the point of the nose is to be formed by this cartilage that is, about 3 cm from the end nearest to the base of the forehead pedicle

Step 4 Outline a flap on the forehead

Step 5 Incise the base of this flap down to the bone for about 5 cm and make tunnel to fit the strip of cartilage

Step 6 Introduce the strip of cartilage with its notch toward the skin surface so that it rests between the frontal bone and its periosteum (Fig 428)

Step 7 Close the skin periosteal incision

Stage

Step 8 Two months later make an incision about the nasal defects in such manner that two lateral and one upper central flap will result

Step 9 Turn these over so that the skin surfaces will look into the cavity of the nose

Step 10 Stitch these in place with catgut so as to retain them in position

Step Cut the flap on the forehead with its pedicle toward the opposite inner corner of the eye over which the flap is [illegible] (as shown in Fig 429) It will be remembered that the flap contains the cartilage of the rib previously introduced The periosteum also is part of this flap

Step 12 The flap is now turned downward over the previously turned flaps fashioned from the margins of the defects Fashion the flap into a part of tip of nose by bending the cartilage where the notch had been cut in thus resulting in a columella

Step 13 Suture the parts into place

Step 14 Close the defect in the forehead either by skin grafts or sliding flaps Joseph Beck states that the defect in the forehead can be covered much better by sliding the skin and making counter relaxing incisions in the hairy portion of the scalp

Stage 3

Step 15 One week later cut the pedicle [illegible] and implant it into the defect at the root of the nose (Fig 430)

Step 16 Further cosmetic readjustments are done subsequently

[illegible] OPERATION

Step 1. A tongue-shaped flap is formed from the upper lip, not including the mucous membrane which has its pedicle at the nasal floor

Step A forehead flap is made with especial attention being given to forming a longer median flap for making the columella

Step 3 The edges of the nasal defect are freshened

Step 4 The frontal flap is brought down and sutured laterally In forming the columella the central flap is sutured to the little flap from the lip so that there are cutaneous surfaces on the outside as well as in the nose, one over the other.

The French Method

The outstanding characteristic of this method is that the flaps used in forming a new nose are taken from the cheeks Because the newly formed nose is

flattened to almost the level of the face by the resulting contraction of the cicatricial tissue, this method is not advocated

[illegible] OPERATION

Step 1. Form a flap from each cheek with its pedicle at the root of the nose (Fig 431A)

Step The inner edges of the flaps are turned down, the center line and the outer edges are brought together with the freshened edges of the defect with sutures (Fig 431 B)

Step 3 Close the wounds in the cheek by means of skin grafts or sutures Insert tube into each nostril

The Italian Method

The restoration of a nose by means of a flap of skin taken from the arm is an operation of Italian origin, Gaspard Tagliacozzi (or -cotti) being the first

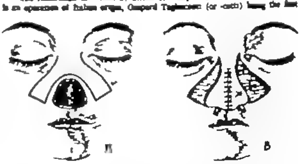


Fig 431 [illegible] rhinoplasty operation (French method) stage [illegible] rhinoplasty operation French method) stage

to use it in 1597 Fabricius used the method later The special feature of this operation is that the pedicle, which is left when the flap of skin is raised from the upper arm, is not divided until after the free portion of the flap has united with the nose This method is now only used when there is no available tissue on the face or when the operator wishes to avoid further scarring of the face The method is also shunned because of the inconvenience the patient experiences by reason of his constrained position in a plaster cast

MacCormac describes the operation as follows

Step Provide a means whereby with the minimum of inconvenience the patient's arm may be kept in the needed position for the requisite period, This takes from [illegible] to 3 weeks.

Step Make a gutta-percha model for the nose and from this pattern the flap to be taken from the arm this should include skin and subcutaneous fat and be twice the size required, thus allowing for shrinkage At the same time arrange for a piece of tissue to be used for the septum, using the anterior surface of the left upper arm near the elbow (Fig 432A)

Step 3. After the flap together. Ah the place for the septum, has been designated on the arm, it is lifted from the underlying tissues throughout its whole length remaining attached only by the two ends. Sterile rubber tissue strips are placed under this bridge and the surfaces allowed to granulate, careful [illegible] being given to asepsis meanwhile. Thus the tissues of the flap thicken and circulation is established before the flap is attached to the face.

Step 4. Detach the upper end of the flap from the arm, make a slightly curved incision parallel to the border of the defect on the right side and suture the edge of the flap into this incision. Apply an adhesive retention dressing as shown in Fig. 431B. Remove the sutures after about ten days and apply a complete immobilization plaster cast (Fig. 431C). Protect the eyes while

Fig. 431. Italian (Tagliacozzi) method of rhinoplasty. A. Formation of flap from arm. B. Suturing flap into place. C. Plaster of Paris immobilization.

putting on the cast, then cut out windows to expose the eyes, ears and mouth. Allow the cast to remain until the parts are healed.

Step 5. After 3 weeks the flap is cut from the arm, and the septum and the other side of the flap are sutured into the freshened edges of the nose.

Step 6. It may be necessary to supplement this with additional minor procedures to perfect the aesthetic requirements of the case.

[illegible] OPERATION

In this procedure, the flap is obtained from the forearm instead of the arm. The arm and forearm are placed in a position to conduce to greater comfort of the patient. The arm is immobilized as in the Tagliacozzi method. The steps of the operation are as follows:

Stage

Step 1. Make symmetrical incisions on both sides of the ulnar edge of the left forearm, resulting in a trapezoid skin flap (Fig. 432A), the lower portion of the trapezoid (pointing toward the wrist), being about 3 cm. from the styloid process.

Step 2. With a chisel, outline a bone flap from the ulna connected with the partially dissected skin; this should be about 6 cm. long and 1½ cm. wide.

Step 3. With [illegible] partially disengage the section of bone from the ulna, taking care that it remains integral with the skin flap and attached to the

upper end of the ulna. Interpose [illegible] or paraffined gauze to prevent union.

Stage

Step 4. A few days later break the bridge of bone at the point where it is proposed to make the tip of the nose. Dress. Wait another four or five days to allow greater thickening to take place.

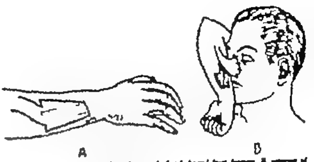


Fig. 432. [illegible] operation for loss of nose. A. Flap fashioned from forearm. B. Suturing of flap into position.

Step 5. After freshening the edges of the nasal defect, transplant the flap of the forearm into it and fix in place with interrupted sutures. Immobilize in plaster of Paris jacket (Fig. 432B).

Stage 3

Step 6. Two weeks later sever the pedicle consisting of bone and skin and shape the tissues to form a nose. The bone should be united with the spine of the nose at the base of the nose. The skin is sutured about the sides of the nose.

Step 7. The nostrils and columella are fashioned from the remaining skin flaps.

Finger Method

[illegible] OPERATION

Stage

Step 1. Incise the dorsal surface of the fourth finger of the left hand medially through the skin and underlying tissues. The incision should extend from the metacarpophalangeal joint to the nail, both sides being dissected freely (Fig. 433A and B).

Step 2. Remove the fingernail, care being taken that the entire matrix is removed with it. Do not disturb the tendon.

Step 3. The skin is removed from the end of the finger in front to be used later at the root of the nose.

Step 4. Make a median incision at the root of the nose through the skin and

subcutaneous tissue to the bone. Separate freely the remaining borders of the apertura pyriformis and the tissues on either side of the incision.

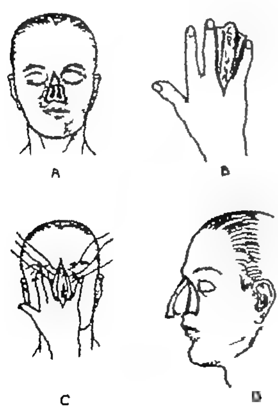


Fig. 433. [illegible] operation for total loss of the nose.

Step 5. [illegible] a suitable bump at the root of the nose, [illegible] is made in the bony structure with a gouge into which the tip of the finger may be inserted.

Step 6. The finger is brought to the root of the nose made ready for it. Its skin

flaps are sutured below the dissected lateral flaps close to the apertura pyriformis, the tip of the finger being fitted into the hollow space at the root (Fig. 433C).

Step 7. The finger is covered at the root while its skin flaps, which are inserted beneath the skin of the nose defect, are joined by two mattress sutures on either side.

Step 8. The median incision at the root of the nose is brought together as far down as possible over the finger and a fairly large amount of [illegible] (Scotch gauze) is inserted below the finger to sustain it in the shape of a nose and a dressing placed over the surface. A plaster bandage is applied in accordance with the usual Italian operation.

Stage

Step 9. Some days later remove the sutures and extend the incision over the back of the hand exposing for [illegible] the entire metacarpophalangeal joint.

Step 10. Divide the skin laterally and suture it on both sides but not in front.

Stage 3

Step [illegible]. During the next five days separate the skin pedicle and disarticulate the metacarpophalangeal joint, at two different sittings.

Step [illegible]. Cover the defect in the hand [illegible] with the remaining skin as in the usual disarticulation procedure.

Step 13. Shape the attached finger into the form of a nose. Insert a new supply of Scotch gauze under it and allow it to remain for three more days so as to become more firmly joined to the surrounding tissue.

Step 14. Bend the finger between the first and second phalangeal joints in such a manner that the first phalanx may be inserted into the nasal cavity.

Step 15. Prepare the floor of the nose and if [illegible] piece of septum is left, remove all mucous membrane so that its bony surface is exposed.

Step 16. After the skin and granulations have been removed from the disarticulated end of the finger it is placed in the floor of the nose against the raw surfaces provided for it (Fig. 433D).

Step 17. Dissect the lateral borders of the apertura pyriformis downward to the point of formation of the alae and tuck under the remnants of the skin flap of the finger and once more fasten these on either side with one mattress suture.

Step 18. A Krause or any other flap is taken from either the forehead or arm and placed over the denuded surface of the bony reconstruction. Minor readjustments such as forming the nostrils and covering the columella are done later.

SUBTOTAL RHINOPLASTY

Nélaton Operation for Extensive Loss of the Nose

Ch. Nélaton devised a most ingenious operation for complete rhinoplasty which is applicable to all cases where a nasal stump remains having a [illegible] of at least 7 to 8 mm.

Step 1. The surgeon takes his position on the left side of the patient and [illegible] the incision at a point on the right cheek which is located a finger

from the nasal bone on line extending from the anterior nasal spine to the lobe of the ear. Following the nasogenal furrow the incision is brought upward, passing 6 mm. inward of the lacrimal caruncle to the eyebrow which is divided vertically at its inner end. The incision is continued directly up-

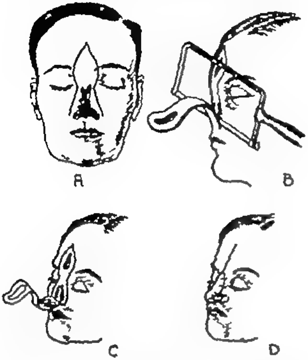


Fig. 435. Hilmer operation for subtotal loss of nose.

ward for short distance after passing the eyebrow and is then directed laterally to the edge of the hairy scalp in the middle line. This is repeated on the left side from below upward ending near the edge of the scalp at the same point. Thus lanceolate-shaped flap has been cut entirely around the defect caused by the destruction of the nose (Fig. 435A).

Step 2. The frontal flap is separated from the bone at its upper extremity and

edges, leaving only long middle strip of the bone attached to the flap from the upper end to the level of the frontal sinus. A side of the flap that has been detached is turned back by an assistant permitting the surgeon to trace groove upward with chisel through the external layer of the bone extending from the frontal sinus to point near the end of the flap. The same course of action is followed on the opposite side and an attempt made, with fine flat chisel, to detach the thin external layer of the bone from above downward. This strip is attached to the flap for breadth of about 3 cm. and is entirely detached from the bone near the frontal sinus. The bony structure at the root of the nasal bones is exposed for about 6 or 8 mm. according to the size of the stump, by the dissection which is continued downward from the region of the frontal sinus.

Step 3. The ascending process of the superior maxilla is dissected by means of saw passing from above downward being directed in line starting cm. in front of the anterior nasal spine and extending toward the internal canthus and ending 6 to 7 mm. in front of and below the lacrimal foramen. If the course of the saw has been clearly revealed and the soft parts freely loosened, the bones can be divided easily (Fig. 435B).

Step 4. A gouge introduced on either side after the saw is withdrawn, is used to fracture the root of the ascending process. Great care must be exercised here. The surgeon completes the fracture in lowering the flap and nasal structures, in such manner that the ascending process is left loosely attached to the body of the maxilla connected slightly by some bony fibers (Fig. 435C and D).

Step 5. The soft tissues are then properly sutured into place.

SIMPLE RHINOPLASTY

Israel' Operation for Saddleback Nose

Step 1. Make an incision cm. long on the outside of the nostril; separate the sides subcutaneously so that when the tip of the nose is pulled upon, normal appearance is obtained.

Step 2. Chisel off from the anterior border of the tibia, piece of bone 3 cm. in length, make sharp points at each end.

Step 3. By means of dissection, the originally separated tunnel is locked from the inside of the nose; the fragment of bone inserted so that the upper end comes in contact with the nasal bone and the soft tissues over it are closed.

Hump Nose

MALLET OPERATION

Step 1. Make longitudinal incision over the most conspicuous portion of the hump dissecting the skin and the periosteum to either side until full exposure is obtained (Fig. 436A).

Step 2. The hump is removed with chisel, being careful not to tear away the mucous membrane or enter the interior of the nose. If, by accident, a tear is made, it should be sutured at once (Fig. 436B).

Step 3. If, in taking away the hump, broad bone defect results, sharper ridge may be obtained by pressing the margins together with heavy forceps.

Step 4. Closure is effected by means of Halsted's subcuticular horizontal suture. The operation may also be done by the intranasal route (Bollinger).

Fig. 436. Hallet operation for "hump nose." A, skin incision; B, chiseling of "hump."

INTRANASAL OPERATION (APPLIED TECHNIC)

Step 1. Make an incision on the inner surface of the lateral side of the nasal vestibule. Direct the blade of the cutting instrument upward and outward until emerges immediately under the skin and perichondrium of the nose. The columellar incision (either through the center or across the columella) leaves an almost invisible scar not usually visible at all since it is along

Fig. 437. Removal of hump. Insertion of the saw and for removing the "hump," the saw in position for removing the "hump." C, saw cut through the intermaxillary junction, the "hump" already having been removed leaving the nasal chamber temporarily open externally.

the base or line of the columella, and is meant for the intraperitoneal operation than the horizontal approach. It is closed with horse-hair sutures (Fig. 437A).

Step 2. Dissect away the skin and subcutaneous tissues from the bone and cartilage of the nose by means of blunt-pointed side-cutting knife introduced into the incision and directed over the bridge of the nose to the opposite side and ending on the tip of the nose.

Step 3. Insert right-angled saw into the wound until the teeth of the instrument lie over the hump (Fig. 437B).

Step 4. Guided by the finger of the left hand, the hump is detached and withdrawn by means of forceps introduced through the original wound (Fig. 437C).

Step 5. Saw entirely through the lateral nasomaxillary connection of each base of the nose.

Step 6. Bring the bones of the nose toward the midline to the width desired.

Step 7. Form splint by molding dental compound material over the nose, holding it in place with adhesive tape.

Perugali' Operation to Lengthen the Nose

In this operation short nose is made longer by means of an inverted V-shaped incision, the point of which should appear in the midline about the level of the canthi and the limbs between the cheek and nose above the alae (Fig. 438A). When the adhesions are loosened and the flap is lifted up, the lips of the wound are brought together in the form of an inverted Y (Fig. 438B). This procedure is not recommended when the nose is too wide. Satisfactory results depend upon normal condition of the tissues.

Szymanowski' Operation to Narrow the Nose

Fig. 438. Perugali's operation to lengthen nose. A, outlining incision; B, after shortening the flaps the lacerated edges are sutured as shown here.

A piece of tissue in the shape of wide triangle is removed from the upper lip, its apex at the midline, slightly above the vermilion border and its base reaching the inner edges of the alae from one side to the other. After the alae are loosened, the incision is brought together in the midline by means of fracture suture through the base of the nose.

If triangular-shaped piece of tissue is removed from under each nostril and strip of skin left between, the same results may be obtained with less injury to the upper lip.

Rhinophyma (Acne Hypertrophica)

General anesthesia.

Step 1. To prevent the inflow of blood, introduce gauze strips through the anterior nares, plugging the posterior two-thirds of the nose and leaving the anterior portion free. The same results may be obtained by plugging the posterior nares.

Step 2. The forefinger of the left hand is introduced into one nostril, as guide. An incision down to, but not into the cartilage of the nose is made, circumscribing the growth from the middle line outwards. Be sure to leave as much skin as possible near the opening of the nares to avoid subsequent constriction (Fig. 439).

Step 3. The end portion of the tumor mass is seized with forceps and held out of the way. Remove all of the diseased tissue with the knife or the scissors. Attend to hemostasis (Fig. 44[illegible]).

Step 4. Steps 3 and [illegible] are repeated on the opposite side.

Step 5. The nasal flaps are loosened. Short drainage tubes are introduced in each nostril. The wounds are covered with gauze [illegible] or [illegible] foil. Apply compression dressings.

SUBMUCOUS RESECTION OF THE NASAL SEPTUM

This operation is indicated in cases of septal deformation which interfere with respiration.

An incision is made in the mucous membrane of the septum, through this incision portions of the bone and cartilage of the nasal septum are removed submucoperichondrially (Figs. 44[illegible] and 44[illegible]).

Fig. 44[illegible]. Operation for [illegible] [illegible] of septum. (Cook County Hospital, Chicago.)

Fig. 44[illegible]. Technic of operation. (Cook County Hospital, Chicago.)

Step [illegible]. Cut the vibrissae even with the alae. Irrigate the nostrils with boric acid solution several times during the 24 hours preceding operation. The skin and mucosa of the vestibule may be painted with tincture of iodine.

Step [illegible]. Local anesthesia is applied as previously described. General anesthesia may be used (Fig. 44[illegible]).

Step 3. Make a curvilinear incision on the convex side of the septum, its extent and direction varying with the nature of the deformity (Fig. 44[illegible], left). The Freer knife should not penetrate beyond the mucous membrane and perichondrium.

Step 4. With an appropriate instrument (some surgeons prefer a sharp and others a blunt one) raise the mucoperichondrium and mucoperiosteum from the involved cartilage and bony structure intact. Avoid injury to the soft parts—this is important (Figs. 44[illegible] and 44[illegible]).

Step 5. If the first incision is made where the mucous membrane of the septum joins the skin of the vestibule, make a similar incision in the septal cartilage

with a sharp knife. A finger inserted in the opposite naris serves as a guide to determine the extent of the incision. If the first incision is made along the anterior border of the septal cartilage, no second incision is necessary.

Step 6. Separate the cartilage and mucoperichondrium on the opposite side with a sharp elevator following the same procedure as in detaching the first side of the nasal septum (Fig. 44[illegible] B).

Step 7. Retract the mucous membrane on either side of the nasal septum with a nasal retractor or speculum, exposing the cartilage. This is cut with a Ballenger swivel knife (Figs. 44[illegible], 44[illegible]) or some other sharp instrument and removed in one piece with forceps.

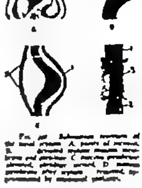


Fig. 44[illegible]. Submucous resection of the nasal septum. A, [illegible] of [illegible]. B, [illegible] deviated septum [illegible] membrane and cartilage. C, [illegible] [illegible] [illegible], cartilage [illegible]. D, [illegible] [illegible] after [illegible], [illegible] by [illegible] [illegible].

Step 8. While the tissues are still retracted, the portion of the perpendicular plate of the ethmoid to be removed is grasped by a Foster-Ballenger forceps and removed in bits. Lateral twisting or wrenching should not be exerted as an unnecessary damage is likely to ensue.

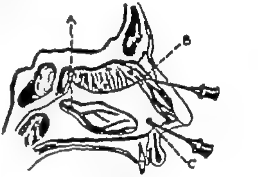


Fig. 44[illegible]. Local infiltration [illegible] for submucous resection of the septum. A, B and C are points of injection. A, [illegible] [illegible] [illegible], B, [illegible] [illegible] [illegible].

Step 9. In excising the deflected part of the vomer, Hartmann's [illegible] [illegible] forceps are introduced into the incision while the tissues are retracted and the desired amount of the vomer is bitten off. Ballenger's or Hajek's chisel may also be used to accomplish this step (Fig. 44[illegible]C).

Step 10. Carefully examine the wound to make sure all corrections have been made. Hemostasis is attained by using gauze pledgets saturated with adrenalin solution. Repair with sutures any inadvertent openings which have been made in the soft flaps.

Step [illegible]. Not all surgeons suture the wound; some leave it open to drain. If suturing is done use a Reverdin or small curved needle. In dressing the

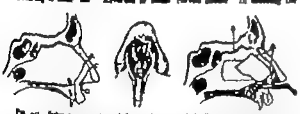


Fig. 44[illegible]. Submucous resection of the nasal septum. Left, The incision [illegible] made on the [illegible] side of the septum from [illegible] to [illegible] the free end of the quadrilateral cartilage [illegible] [illegible] from behind the [illegible] part [illegible] the septum, and [illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] [illegible] from C to [illegible]. Center, Nasal speculum [illegible] inserted between the mucoperichondrium on either side of the septum showing the use of Ballenger's swivel knife. Right, [illegible] [illegible] [illegible] with chisel. A, Portion of cartilaginous septum removed. B, Portion of bony septum taken away.

wound, endeavor to bring the raw edges of the wound together to prevent hematoma formation. To accomplish this, insert one or two Simpson-Bernays [illegible] sponge-tents in each nostril and drop sterile water on them until the desired expansion is reached. Todd splints may also be used and the nostrils left open. After removing the splints, irrigate the nose with a mild antiseptic.

Comment. To prevent the bridge from sinking, do not remove the cartilage too close to it; leave a quarter inch or more attached. Avoid mutilating the mucosa during the operative manipulations and hematomas from forming.

ABSCESS OF THE NASAL SEPTUM

This condition follows either trauma to the nose or is a postoperative complication of submucous resection. It is usually the result of infection of hematoma of the septum.

Step 1. Make a vertical line with [illegible] placed over the more swollen side of the septum. Make a vertical incision through this line, cutting through the mucous membrane only.

Step [illegible]. Remove all the necrotic cartilage from between the flaps of mucous membrane.

Step 3. Remove a large triangular section of mucous membrane from the side that has been incised. Do not pack the nares.

Comment. It is important to warn the patient that a saddle nose may result as a result of destruction of cartilage. This can later be repaired. The drainage of the abscess should be done as early as possible to minimize the amount of deformity that results.

TUMORS OF THE NOSE

Operation for Removing Nasal Polypi with a Snare

Step [illegible]. After thoroughly anesthetizing the tissues as described, introduce the wire snare so that it is vertical to the floor of the nose.

Step [illegible]. Direct the snare along the side of the polyp until its lowest portion comes immediately below the margin of the polyp where it is manipulated until the polyp drops through it.

Step 3. While encircling the growth, the loop of the snare is directed toward the middle meatus. Endeavor to insert the tip of the cannula into the meatus (Fig. 44[illegible]).

Step 4. Grip the shaft of the snare with the finger tightening the wire loop, and pull down the cannula.

Step 5. With the snare firmly grasping the polyp, it is detached from its bed by a quick forward movement.

Step 6. If the polyp is not withdrawn with the snare, instruct the patient to blow the nose with force; if this does not suffice, the growth is removed with suction or forceps.

Comment. Polypi appearing in the posterior part of the nose are removed in a similar manner and may be brought forward by the patient blowing the nose or by means of suction. As a rule, there is little bleeding connected with this operation and any oozing is taken care of by means of cotton pledget compression.

Fig. 444. Ballenger [illegible] [illegible].

Denker's Transmaxillary Excision of Intranasal Malignant Tumors

Step [illegible]. Pull up the angle of the mouth and upper lip with blunt hooks. Make a slightly curved upward incision through the gum of the upper jaw to a point near the frenum of the upper lip, beginning opposite the wisdom tooth. Separate the soft parts of the upper jaw with a periosteal elevator. Expose the bone nearly to the lower margin of the orbit, laying bare the pyriform aperture of the nose.

Step [illegible]. Separate the mucous membrane from the outer wall of the lower and middle meatus of the nose and partly from the floor of the nasal beginning at the pyriform aperture. This separation is continued backward to the posterior limits of the antrum of Highmore. If the lower turbinate bone

is not involved in the tumor it is removed with strong scissors Hemostasis is obtained by temporary packing with gauze

Step 3 Remove the external bony wall of the antrum of Highmore with chisel and hammer If the mucosa lining the inner surface of this wall is uninfected, incise freely so as to gain free access to the antrum If it is involved in the neoplasm, remove it together with the growth Remove the bone completely and also the mucosa of the inner or nasal wall of the antrum of Highmore

Step 4 With scissors or probe pointed knife remove the mucosa of the already separated outer wall of the nose (See Step) If the tumor originated from the middle meatus of the nose it generally will follow with the removal of the

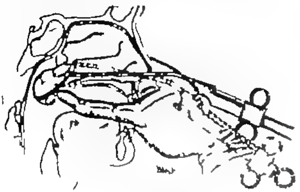


Fig. 442 Removal of ethmoid polyp with snare

nasal mucous membrane The ethmoidal and sphenoidal sinuses are now accessible and may be taken care of as usual by

Step 5 Pack the wound with gauze Suture the wound in the mouth Insure oral asepsis with mouth washes After three or four days the pack is removed Tumors arising from the nasopharynx, retro-maxillary or pterygopalatine fossae are not amenable to the above procedure

Comment Malignancies on the cutaneous surface in the region of the nose may at times be treated successfully with radium (Fig 443A and B). Proper prosthesis yields satisfactory results (Fig 443A and B).

FOREIGN BODIES IN THE NOSE

Children are the usual patients who introduce foreign bodies into the nasal chambers. These usually consist of nuts, peas, beans, etc which tend to swell and give rise to difficulties

If anterior rhinoscopy fails to reveal the foreign body one may resort further

developments. Where a child is suffering from chronic, unilateral nasal discharge (purulent or muco-sanguineous) or if there is a dermatitis of the nostril the presence of a foreign body may be assumed If the case is recent, anterior

Fig. 443. A Epithelioma of the nose. B Same patient after radium treatment

rhinoscopy is likely to reveal it; but, if of long standing, the swelling of the mucosa and the discharge are likely to conceal the foreign body Shrink the

Fig. 444 A Cancerous destruction of the nose. B Nose restored by prosthesis (courtesy of Dr E [illegible])

mucosa with cocaine and adrenalin and wipe away the discharge, then search for the foreign body In very young children or youngsters hard to handle, it may be necessary to resort to general anesthesia for examination and removal A

two and one half per cent cocaine solution may be sprayed into the affected nasal chamber and the foreign body located and removed with an appropriately bent

Fig. 445. Removing foreign body from nose by an assistant. Most peripheral movement helped and drawing [illegible] foreign body being pushed along roof of nasal chamber. [illegible] Foreign body being propelled along floor of nasal chamber

probe, or forceps (Fig 445) A suction apparatus may be employed to remove any remaining debris

CHAPTER 17

SURGERY OF THE NECK AND CERVICAL ENDOCRINE GLANDS

INJURIES TO THE NECK

CUT THROAT

In cases of attempted suicide, the superficial structures alone are injured in about 90 per cent of cases Occasionally the larger vessels in the neck are severed with fatal outcome The treatment here is careful, aseptic repair of the divided tissues

Deep Wounds of the Neck

These are divided by Hamilton Bailey into definite categories, depending upon the position of the injury inflicted, viz. (Fig 449)

WOUNDS ABOVE THE HYOID BONE

In this locality the wound may often lead into the mouth and the epiglottis will in many cases be found injured The principles of treatment are

Step 1. Asepticize the wound

Step Repair the epiglottis with catgut sutures

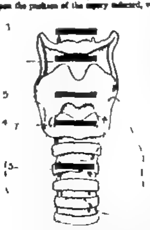


Fig. 449

Fig. 450

Fig. 449. Position of the wound into the air passages of [illegible] "cut throat" with deep wounds Above hyoid (1) [illegible] Thyrohyoid membrane [illegible] Thyroid cartilage (3) Cricoid [illegible] Trachea (5) (After Hamilton Bailey)

Fig. 450. Suturing of injured thyroid cartilage. (After Hamilton Bailey)

Step 3 Trim the mucosa of the pharynx and repair the wound

Step 4. If the submaxillary gland is much traumatized, remove

Step 5 Ligate spurting vessels

Step 6. Mop out the entire wound cavity with tincture of iodine

Step 7 Close the cutaneous wound

WOUNDS OF THE THYROHYOID MEMBRANE

Step 1. Repair the epiglottis as above.
Step 2. Suture the thyrohyoid membrane and close any chance opening into the pharynx.
Step 3. Laryngotomy is indicated in most cases. Bailey lauds this procedure and prefers it to tracheotomy. In the presence of respiratory embarrassment laryngotomy (see p. 3[illegible]) should be done before the wound is attended to.

WOUNDS OF THE THYROID CARTILAGE

Step 1. Perform laryngotomy as described on p. 357.
Step 2. Introduce mattress sutures of catgut as shown in the illustration (Fig. 4[illegible]). Approximate the lips of the wound in the cartilage; do not tie the sutures too snugly because sutures pulled too snugly tend to cut out.
Wounds with loss of substance of the thyroid cartilage should be repaired by covering the defect with muscle—usually available from the prethyroid group of muscles.

WOUNDS ABOVE, BELOW OR THROUGH THE CRICOID CARTILAGE

Step 1. Expose the wounded structures thoroughly. Trim away crushed edges.
Step 2. Insert a laryngotomy tube.
Step 3. Approximate the tissues around it.

WOUNDS OF THE TRACHEA

Step 1. Good exposure here is essential.
Step 2. Bare the trachea by Digby's method, which consists of making a tunnel with a pair of curved, pointed hemostats between the isthmus of the thyroid and the trachea. Divide the isthmus between two artery forceps, the hemostat behind acting as a protector of the trachea while the incision is being made. The trachea is now exposed.
Step 3. Insert an ample-sized tracheotomy tube into the opening in the trachea. Or, close the wound in the trachea and do a tracheotomy below the closed tracheal wound.
Step 4. Resuture the divided isthmus of the thyroid with catgut sutures.
Step 5. Insert hemostats. Drain the wound.

Complications of "Cut Throat." (a) Bronchopneumonia, (b) cervical cellulitis (not frequent), and (c) esophageal fistula.

WOUNDS OF THE VESSELS IN THE NECK

(See Chapter [illegible], p. 3[illegible])

FRACTURES OF THE LARYNX AND TRACHEA

(a) Simple fractures not interfering with breathing should be treated conservatively but the surgeon should always be prepared to interfere should an emergency arise.
(b) When respiratory embarrassment is present, do a tracheotomy at once.

RUPTURE OF THE TRACHEA WITH RETRACTION OF THE LOWER END

Search for the lower end of the windpipe, bring it to the surface, secure it there with sutures after a tube has been inserted. Transverse wounds of the trachea should be sutured.

FOREIGN BODIES IN THE PHARYNX AND ESOPHAGUS

If the foreign body has just been swallowed, introduce the index finger into the pharynx, sweep it to the back of the epiglottis. If you feel the foreign body dislodge and extract it promptly.

If suffocation is imminent do a tracheotomy promptly!

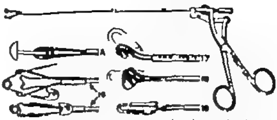


Fig. 4[illegible]. Forceps for extracting foreign bodies from pharynx and esophagus.

Where no speed is indicated, explore the pharynx, hypopharynx and esophagus (smooth, x-ray, etc.). When located, remove the obstruction with a foreign body extractor (Fig. [illegible]). When the foreign body is in the grasp of the instrument proceed slowly, extricate methodically, without haste, lest serious injury to the esophagus and contiguous structures result.

Where esophagoscopy can be done it should be resorted to—it is the safest and best aid for exploration and extraction of foreign bodies.

BURNS AND SCARS

Scars caused by burns are always most disfiguring but seem to be doubly so when occurring on the neck where they frequently draw the mouth, chin and lips out of shape; they impede speaking, pull the chin downward and occasion different degrees of torticollis. Treatment of burns here requires great caution and care. If the burn covers a large area, a tent should be built over the patient and an electric lamp placed under it for heating purposes. Sterile vaseline and albolene are used to keep the surface soft and pliable. The tannic acid treatment is excellent (for which see p. 3[illegible]).

As soon as possible skin grafting should be resorted to (pinch grafts). *On account of the movements of the neck, every effort should be made to keep the grafts in place with wet sponges.*

Surgery of Scars

Scars which displace the chin downward demand surgical treatment in order to free the jaw. Often such operation, if carelessly performed, may lead to the formation of more scar tissue. Individual option and judgment must be exercised in each case. A number of plastic procedures may be necessary, and pedicled flaps from the skin of the breast or thorax may have to be resorted to. If a scar running from the chin to the neck contracts a ridge of skin that somewhat round, make an incision along the length of the scar. Incise two lateral and

Fig. 4[illegible]. A. Extensive scarring of neck and chest following burns. B. Same patient after multiple plastic operations.

incise these so as to form right angles to the original incision but at different points, separate flap one near the chin and the other farther down.

Figure 4[illegible]A depicts a young woman who was desperately ill following burns. The neck and substernal region were a firm mass of scar tissue. Careful and painstaking plastic procedures enabled me to obtain the result shown in Fig. [illegible]B.

INFECTIONS OF THE NECK

FURUNCLES AND CARBUNCLES OF THE NECK

Carbuncles should receive early attention. Poulticing and injections of antiseptics should be abandoned for more effective treatment thus diminishing the destructive process and bringing about quick relief. Ethyl chloride is recommended by Franke. It should be used properly to produce effective anesthesia and prevent the danger of gangrene. Occasionally block anesthesia is permissible. Gas or other anesthesia is usually employed. Operate quickly. L. Carp

concludes that in large carbuncles of diabetic or non-diabetic origin, the treatment *of choice is radical surgery. In preparing the skin before the operation, soap and alcohol are generally used in preference to iodine.* Excision is the treatment of choice (Figs. [illegible]). The majority of furuncles are best treated by conservative measures (hot, saturated boric-acid applications and general sustaining

Fig. 4[illegible]. Carbuncle of back of neck.

measures). When fluctuation presents, incise. Crucial incisions are often effective. (See also, [illegible] treatment of, p. [illegible])

CELLULITIS AND LYMPHADENITIS

Infections in the upper neck are by no means rare. In school children enlarged lymph-nodes caused by colds or fevers are usually of no consequence. In some cases, however, persistence occurs, the nodes fuse together and an abscess may form; this should be guarded against by proper preventive measures. Iodine and other counterirritants are contra-indicated in acute cases but may prove useful in chronic conditions.

In deep infections where pus has accumulated in the structures of the neck,

of the trachea (obliquely) and may be from one half to an inch above the supra-sternal notch.

Tracheotomy, under certain conditions, is a very simple procedure. Again it may be difficult to accomplish (emergency, alarming dyspnea, improper surroundings, poor assistance, etc.)

Types of Operation. High tracheotomy (above the isthmus of the thyroid gland)

Fig. 462. Fig. 463.

Fig. 462. Laryngotomy. [illegible]

Fig. 463. [illegible]

Caution. In low tracheotomy the skin incision must be ample in order to avoid [illegible] A dry field is essential. A blood clot or mucous plug in the trachea may prevent proper aeration. Any tendency to dyspnea must be investigated and the causative factor eliminated.

Complications. Aspiration of blood or mucus causing respiratory embarrassment (bronchopneumonia, tracheobronchitis, etc.)

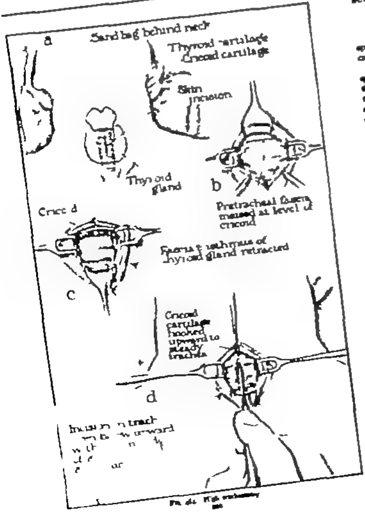


Fig. 464. High tracheotomy

Pressure necrosis from improperly placed tube.

3. Dislodgement of the tube with ensuing threatened suffocation. (Act promptly; remove the tube at once.)

High Tracheotomy

Position of the patient. Place the patient on his back with the shoulders raised on a pillow or sand bag and the head extended. Good illumination is essential.

Anesthesia may be local or general. Palpate the thyroid and cricoid cartilage.

Step 1. From a point below and at the middle of the thyroid cartilage, make an incision exactly in the midline, about 1½ inches in length (Fig. 464 A). The sterno-thyroid and the sterno-hyoid muscles are retracted laterally and the isthmus of the thyroid is pushed downward. Catch all bleeding vessels and ligate them (anterior jugulars). Expose the pretracheal fascia and incise it transversely at the level of the cricoid cartilage (Fig. 464 B). If the isthmus cannot readily be displaced it is best to divide it between two ligatures (Fig. 464 C). The upper three or four tracheal rings are then exposed.

Fig. 465. [illegible] tracheotomy tube with pilot.

Step 2. Steady the cricoid cartilage with a sharp hook which pulls the cartilage upward (Fig. 464 D). Incise the trachea from below upward. Care should be taken not to push the knife so far as to injure the posterior wall of the trachea. Two or three tracheal rings are divided. The incision in the trachea is about ½ of an inch in length. A pair of hemostats spreads the opening conveniently. Introduce a tracheotomy tube (Fig. 465) or suture the edges of the tracheal opening to the edges of the skin. One suture on each side suffices to keep the tracheal opening patent.

If a tube is used its size should suit the opening in the trachea (Fig. 466). After the tube is properly placed, it should be secured by a tape around the neck to prevent it slipping out.

Low Tracheotomy

Step 1. The incision in this operation begins near the cricoid cartilage and extends downward for about [illegible] inches.

Step 2. Divide the fascia and expose the trachea. Ligate and divide vessels as they appear. Vigil is essential to discover any abnormal vessels crossing the operative field. (Fig. 467 A.) If the isthmus of the thyroid interferes with exposure pull it out of the way (upward). A study of Fig. 467 shows why

the low operation should not be used in children (vascular anomalies, deep position of the trachea, short necks, thymus gland).

The trachea is opened in the same manner as in the high operation. (Fig. 467 B.) Same object to high tracheotomy because of the possibility of laryngeal stenosis.

Comment. The inner tracheotomy tube should be frequently removed and cleaned. During the first few days after the operation the outer tube should never be removed except by the surgeon. The nurse or patient should never be permitted to remove the outer tube until the surgeon is satisfied that they are capable of replacing it.

Fig. 466. Tracheotomy tube.

[illegible] TRACHEOTOMY [illegible]

Step 1. (Fig. 468) Make an incision in the midline extending from the upper border of the cricoid cartilage and continued downward for about 1½ inches. Divide the cervical fascia longitudinally. Expose the cricoid cartilage.

Step 2. Make a transverse incision into the fascia attached to the lower border of the cricoid cartilage, thus exposing the beginning of the trachea (Fig. 468).

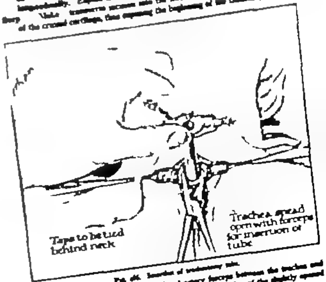


Fig. 468. Insertion of tracheotomy tube.

Step 3. Introduce the point of a closed artery forceps between the trachea and the isthmus of the thyroid gland. A to-and-fro motion of the slightly opened

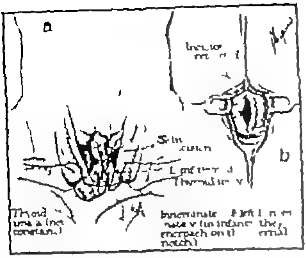


Fig. [illegible] Low tracheotomy.

Fig. [illegible] Tracheotomy. The assistant standing at the patient's [illegible] places his right hand on the forehead and his left on the occiput. He thus fully controls the neck, and holds the head firmly in this position until the tracheotomy tube [illegible] firmly placed. (After Hamilton Bailey.)

forceps will aid in its passage. The isthmic tissue is raised and the hemostat is kept close to the midline. A second artery forceps is placed parallel to the first (Fig. [illegible]).

Step 4. Divide the isthmus between the artery forceps and rotate these laterally to about 90 degrees. In so doing depress the handles of the forceps somewhat so as to raise the points of the hemostat, thus separating the tissues from the trachea; this is to be aided by [illegible] of the scalpel where necessary. The first four rings now be clearly exposed.

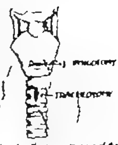


Fig. [illegible] Emergency openings of the trachea. (Hamilton Bailey.)

Step 5. Now make [illegible] vertical incision dividing the second, third and fourth tracheal rings. Pick up one edge of the wound in the trachea with [illegible] dissecting forceps, snip off one or two of the tracheal rings and repeat the procedure on the other side—an oval window then results on the anterior surface of the windpipe. This is preferable to passing the tube through [illegible] tight vertical opening.

Step 6. Ligate the divided isthmus. Insert the tracheotomy tube as described above.

Step 7. Close the skin around the tube.

Fig. [illegible] The isthmus of the thyroid is divided between artery forceps and the trachea incised. The [illegible] [illegible] artery forceps [illegible] the isthmus [illegible] [illegible] the trachea. (Emergency Surgery, Hamilton Bailey, John Wright [illegible])

ST. CLAIR THOMSON'S PROCEDURE—(TRANQUIL TRACHEOTOMY)

Sir St. Clair Thomson characterized his procedure in the following terms: The calm with which this procedure takes place is in striking contrast with the agitated, hurried and often bloody and dangerous operation of former days.

The principle underlying the procedure is based on the elimination of the [illegible] which attends the first entry of air into the trachea. This is accomplished by the use of intratracheal solution of cocaine which is accomplished as follows.

Step [illegible]. Fill [illegible] hypodermic syringe with [illegible] drops of [illegible] per cent solution of cocaine for an adult; for [illegible] child, [illegible] drops of [illegible] per cent solution.

Step [illegible]. Lay bare the tracheal rings as described above. Grasp the syringe as you would [illegible] pen, placing the forefinger about an inch down from the extremity of the needle. The middle, ring and little fingers rest on the patient's neck thus preventing the point of the needle from entering the lumen of the trachea for more than [illegible] quarter of an inch.

Fig. [illegible] Tranquil tracheotomy by injecting a solution of cocaine into the lumen of the trachea. (After Sir St. Clair Thomson.)

Step 3. Inject the cocaine solution into the lumen of the trachea (Fig. [illegible]). Withdraw the needle briskly. Immediately upon the solution entering the trachea [illegible] slight cough [illegible] promptly produced which, however, does not cause much distress. If the condition is not urgent about ten minutes should elapse to allow the cocaine to take full effect. At the end of that period the incision can be made into the trachea and the tube inserted without spasm or cough.

Step 4. Complete the operation as outlined above.

TRACHEOTOMY IN EMERGENCY CASES

Step [illegible]. Extend the patient's head. Palpate the cricoid cartilage. Make the skin of the prominent region tense. (Fig. [illegible])

Step 2. Make [illegible] longitudinal incision exactly in the midline, about [illegible] inches in length.

Step 3. Lift up the larynx by placing [illegible] sharp hook under the cricoid cartilage which is steadied with the left hand.

Step 4. Direct the cutting edge of [illegible] narrow bladed knife toward the patient's

chin and thrust the knife about half an inch below the cricoid cartilage into the trachea. Extend the incision somewhat upward. Air will now rush into the opened trachea.

Step 5. Guide the point of an artery forceps along the blade of the knife into the opened windpipe. Spread the blades of the hemostat while the scalpel is withdrawn.

Step 6. Insert a tracheotomy tube. Release the sharp hook from under the cricoid cartilage.

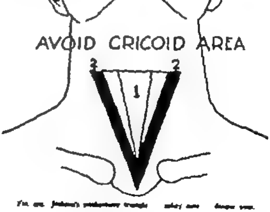


Fig. [illegible] Jackson's tracheotomy triangle [illegible] safety zone [illegible] danger zone.

Step 7. Close the wound. Dress.

Comment. In these urgent cases, waste no time in preparations. Procrastination often spells death. Act promptly! On occasion, the resourceful surgeon will have to depend upon a pocket knife and [illegible] tube. The desideratum is to get air to the suffocating patient as promptly as possible.

INTUBATION

(Tubage)

This operation was first recommended by Loiseau and Bouchut (France 1858). In England the procedure was championed by Sir W. Macewen and in America by O'Dwyer of New York.

Advantages of Intubation.

[illegible] No anesthetic is required.

[illegible] No operation is performed.

3. Performance is rapid.

Breathing is continued through natural air passages.
3 Better results are obtained in children under five years of age
4 Recovery is quicker

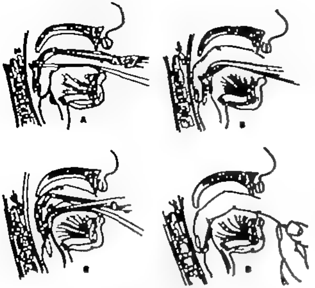


FIG. 473. Intubation. A. Elevate the epiglottis and draw the tongue forward with the finger directing the tube into the larynx, ... B. The tube ... passed under finger. C. The tube ... passed into place with the finger and detached from the introducer. The tube ... held in place by the finger

Disadvantages.

Requires special training and instruments.
Must be performed quickly ... respiration is embarrassed during introduction of the tube
3. The tube may be coughed up or blocked; drainage is inefficient.
4. Complications are frequent (bronchopneumonia, ulceration, stenosis)
5. Feeding after treatment demands constant watchfulness.
6 Secondary tracheotomy is frequently necessary (about 30 per cent)
7 Tube difficult to keep in place

The choice between tracheotomy and intubation depends upon the experience of the surgeon. Generally it may be stated that in selected cases with an experienced surgeon, the method is valuable

In this procedure it is necessary that the surgeon's fingers be trained to recognize the epiglottis, the arytenoid cartilages and the laryngeal entrance since the hands place the tube almost entirely without sight.

Step 1. Fix the mouth open. Locate the entrance to the larynx with the left index finger which has been protected by bandage

Step 2. Now place the left index finger on the posterior surface of the epiglottis to serve as a guide for the tube which is mounted on a special curved instrument and carried into the larynx where it remains in place without aid be-

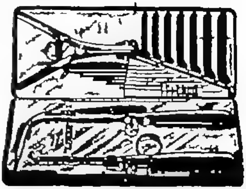


FIG. 474. Ernst-O'Dwyer's intubation set

cause of its length and shape (Fig. 473 A, B, C and D). The larger part of the tube rests below the cricoid cartilage and its funnel-shaped upper end on the aryepiglottic folds.

The instruments which are absolutely necessary are a mouth gag, an introducer and a laryngeal tube of proper dimensions (Fig. 474).

Comment. No anesthesia is employed. An assistant is necessary to help hold the patient and supervise the procedure. The patient is held between the knees of the assistant who sees that the body is kept in an upright position with the head on the assistant's left shoulder; the patient's hands are held firmly by the assistant. The surgeon takes his position on a stool facing the patient. The cannula is inserted alongside of the finger until it reaches the larynx (Fig. 473 A and B). At the first inspiration of the patient the cannula is inserted into the glottis and the carrier withdrawn (Fig. 473 C). The string which has been placed in the cannula need not be removed as it is helpful in removing the tube. In order to be sure the tube is properly placed, insert a finger after the tube has been placed in position; if the larynx can be palpated posteriorly, the tube is correctly placed. If not, the tube must be replaced. If the tube cannot be properly placed in three efforts, do a tracheotomy. It is usually left in about 4 days

PHARYNGOTOMY

While the patient is lying on his back with his head extending over the operating table and a cushion under his shoulders, locate the hyoid bone and thyroid cartilage with the fingers (Fig. 475)

Step 1. *Incise the skin transversely parallel to and directly under the hyoid bone* (Fig. 476). An incision [illegible] inches long is adequate to expose the entrance of the larynx, but if there is a growth in the pharynx or upper larynx, the incision must be longer

FIG. 475. Subhyoid pharyngotomy. Locating the thyrohyoid space.

Step 2. Incise the platysma myoides, omohyoid, sternohyoid and thyrohyoid muscles near the hyoid bone, permitting enough of these structures to remain so that they may be sutured (Figs. 477-478)

Step 3. With a cutting instrument directed backward and upward, incise the thyrohyoid membrane near the posterior surface of the hyoid, allowing enough of the membrane to remain for suturing purposes. Check bleeding

Step 4. While exercising care so that the epiglottis is not injured, grasp the mucosa with a forceps during separation and incise it. In the upper margin of the incision, place two sutures of catgut to act as guides when the edges of

the wound are being approximated. Place a suture in the epiglottis for the same purpose. Adequate exposure of the upper larynx or lower pharynx is now accomplished. In cases of malignancy of the upper larynx or if undue bleeding is expected perform a preliminary tracheotomy. A foreign body or tumor mass can be removed, or it be burnt electrocoagulated

Step 5. Reunite the incision in the mucous membrane with fine catgut sutures,

FIG. 476. Incisions used in some operations in the neck. 1. Subhyoid pharyngotomy 2. Laryngofissure 3. Lateral pharyngotomy 4. Inferior tracheotomy

suturing the thyrohyoid membrane, muscles and skin separately. Drain through gauze or tied with inserted drain to the suture-line in the mucous membrane. If most of the pharynx has been dissected, fill the space with gauze and leave the incision partly open. In such cases a tracheotomy becomes imperative

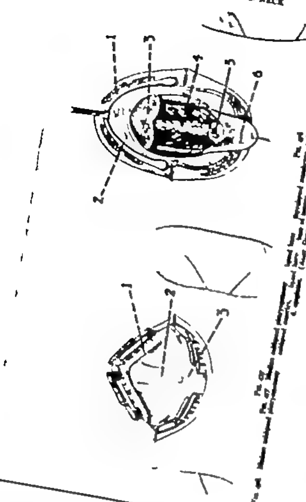
Transhyoid Pharyngotomy

Yields adequate central division of the pharynx

Step 1. Incise the skin, subcutaneous tissue and mylohyoid muscles in the midline from a point slightly above the hyoid to the notch of the thyroid

Step 2. Completely expose a small piece of the hyoid bone in the middle and divide it by means of scissors or forceps

Step 3. Create a space about ½ inches wide by retracting the two portions of



the hyoid bone, thus obtaining exposure of the mucosa of the pharynx above and the thyrohyoid membrane below the bone.

Step 4. Incise the pharynx from above downward, being guided by a finger introduced into the pharynx through the mouth.

Step 5. Attend to the carcinoma which prompted the operation. Provide appropriate drainage. Suture the tissues in layers. The hyoid bone need not be sutured.

Suprahyoid Pharyngotomy

This operation is recommended by Trotter, Grunwald, Federoff and many others when tumors are present, particularly if at the base of the tongue and the epiglottis. No preliminary tracheotomy is required. The patient is placed on his back, his head falling backward over the end of the operating table. A cushion is placed under his shoulders.

Step [illegible]. At about a quarter of an inch above the hyoid bone make a transverse, concave incision upward including the skin and platysma.

Step [illegible]. The submaxillary gland which now comes into view is drawn back. Protect the insertions of the digastric muscle. Separate the stylohyoid, geniohyoid and hyoglossus muscles by a transverse incision. The pharynx is incised carefully avoiding the epiglottis, and complete exposure of the pharynx with palatine tonsils, epiglottis and base of the tongue is accomplished. If it is necessary to operate on the base of the tongue, a sharp tenaculum is used to draw that organ into the wound.

EXTERNAL ESOPHAGOTOMY

This is indicated in cases of foreign bodies which cannot be attached otherwise also in stenosing strictures which are so situated that dilatation per os is impossible and in certain diverticula (Figs. [illegible]). Where the indication is the removal of a foreign body, external esophagotomy should be undertaken within 12 hours after other modes of attack have failed. In this operation, where the up and down movement of the foreign body threatens to inflict serious injury or where bleeding forces the surgeon to prompt action. Periesophageal infections and symptoms of mediastinitis indicate immediate operation.

Infiltration, block or general anesthesia may be resorted to in approaching the esophagus in its cervical portion.

Strictures in the neck should be incised longitudinally so that healing takes place transversely thus widening the diameter of the esophagus. In strictures located below the upper thoracic opening the operation is performed for the purpose of permitting dilatation, also for dividing strictures located below the upper opening of the thorax through the esophagotomy opening. External and internal esophagotomy may be combined (see also Surgery of the Esophagus in Chapter on Surgery of the Chest).

Operation. This may be performed on either side of the neck but is usually done on the left side. Guard against injury to the recurrent laryngeal nerve (Fig. [illegible]). If a foreign body is to be removed, its location determines the side to be operated upon.

Step [illegible]. Make an incision along the front margin of the sternocleidomastoid

muscle extending from the hyoid bone to the clavicle. The skin, platysma and superficial fascia are included in the incision.

Step 2. Draw back the sternocleidomastoid muscle laterally and the sternohyoid mesially. Incise the omohyoid muscle mesially to the carotid sheath, exposing the middle layer of deep cervical fascia covering the thyroid gland and permitting access to the esophagus (Figs. [illegible] and [illegible] A).

Step 3. Draw the thyroid gland, larynx and trachea to one side and the sternothyroid, sternocleidomastoid, sternohyoid muscles and large vessels to the other, exposing the inferior thyroid artery and the longus colli muscle in the background.

Step 4. Doubly ligate the inferior thyroid artery and divide it between ligatures, exposing the esophagus. Avoid injury to the recurrent laryngeal nerve between the esophagus and trachea; if necessary draw the nerve toward the middle with a hook.

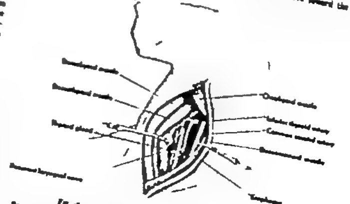


Fig. [illegible]. Exposing the esophagus. (Davis' Applied Anatomy.)

Step 5. Incise the esophagus on its posterolateral aspect. The insertion of ligatures is very helpful. If a foreign body is to be removed, grasp and extract it carefully (Fig. [illegible] B).

Step 6. Introduce a stomach tube through the esophagotomy incision for feeding purposes. Place one ligature close to the esophagus below the tube and another in the direction of the mediastinum. Close the remainder of the wound in the esophagus in two layers. In some cases temporary gastrostomy may be indicated.

Leave the wound entirely open, changing the dressing frequently if symptoms of periesophageal inflammation are present. Remove the tube in about a week.

Apply gentle compression dressing to the wound for few days following the removal of the tube.

If during the manipulations little trauma has been inflicted on the esophageal wall, double row of catgut sutures are used to close the wound. Suturing, however, is generally done under difficulties since only the outer surface [illegible] treated by surgical means. Even though the incision in the esophagus is closed thorough drainage must be provided for the external incision as well as toward

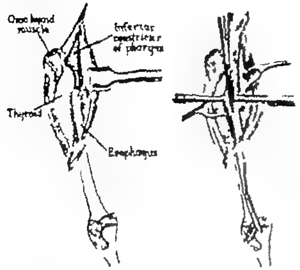


Fig. 283. External esophagotomy. A, Note the omohyoid muscle has been divided and the inferior constrictor of the pharynx retracted. The thyroid and the sternocleidomastoid muscles have been retracted to expose the esophagus. B, Removal of foreign body from the esophagus by external esophagotomy. [illegible] instrument [illegible] through the distal [illegible] and [illegible]

the mediastinum. Hans reports mortal outcome of the esophagus following median [illegible] incision in areas [illegible] be sutured. He states that this less difficult and the sutured closure less dangerous by reason of the trachea lying over it.

Dangers. Aspiration pneumonia, the result of anesthesia, swelling of the throat, the result of manipulations, and local inflammation and suppuration as well as mediastinitis may ensue following the operation. Hemorrhage, [illegible] or sepsis are possible sequels. Esophageal and [illegible] fistulas often close spontaneously but occasionally they call for surgical repair.

MAJOR LARYNGEAL OPERATIONS

Billroth performed the first laryngectomy for carcinoma of the larynx in 1873 (Fig. 284). Total extirpation of the larynx is usually called for when malignant disease is present to such an extent as to involve both lateral halves of the organ. Although in some instances it may be [illegible] it is more usual to perform a prior

Fig. 284. Carcinoma of the larynx.

tracheotomy which may be done some days previous to or immediately preceding the main operation. The greatest danger in laryngectomy [illegible] not so much the immediate risk of the operation as aspiration pneumonia.

Median Thyrotomy or Laryngofissure

This procedure is indicated for diagnostic purposes, removal of foreign bodies or growths from the larynx or preparatory to some other operation; it is not [illegible] procedure. Complete exposure is obtained by dividing the anterior aspect of the larynx in the middle and separating it; the larynx is later sutured.

Hemilaryngectomy or Partial Laryngectomy

This procedure holds [illegible] position between laryngofissure and total laryngectomy and may prove more dangerous than either. It is indicated in cases of [illegible] accompanied by cartilage necrosis and malignancies which involve the adjacent cartilage. It consists of the removal of a portion of the larynx.

It may be performed under local (infiltration or block) anesthesia.

Total Laryngectomy

Step [illegible]. Make an incision in the median line of the neck starting above the hyoid bone and extending to about an inch above the sternum (Fig. 285 [illegible]). The thyroid cartilage and tracheal rings are exposed (Fig. 285 b).

Step 2. Divide the isthmus of the thyroid gland in the midline and ligate the stumps (Fig. 285 [illegible]). The infrahyoid muscles are drawn back after being detached from the thyroid cartilage. Retract the sternohyoid and divide the sternothyroid muscles; retract the lobes of the thyroid gland from the larynx and trachea to the desired distance.

Step 3. Ligate the superior and inferior laryngeal arteries and branches as well as their related veins.

Step [illegible]. A single median incision may suffice but it is generally advisable to make additional incisions above and below forming flaps which when drawn back facilitate dissection.

Step 5. Insert two strong silk sutures transversely through the anterolateral aspects of the trachea between the first and second rings of cartilage, then pass one end of each suture through the skin and clamp the loose ends in pairs.

Step 6. Incise the trachea above the sutures between the first tracheal ring and the cricoid cartilage, directing the instrument from the front to the back and from below upward, being careful not to injure the esophagus. The lower end of the trachea is detached from the esophagus and drawn forward.

Step 7. Make small transverse incision above the suprasternal notch. Make tunnel by blunt dissection through the connecting tissue to the main incision.

Step 8. Bring the two pairs of sutures attached to the trachea through the transverse wound by means of an artery clamp, with the end of the trachea following. One suture of each pair is inserted through the adjoining skin on either side and tied to its partner in like manner; sutures [illegible] passed above and below. The trachea should be sutured to the dermis as possible.

Step 9. Insert tracheotomy tube in the loose end of the trachea and continue anesthesia through it, thus protecting the lungs from aspiration (Fig. 285 d and [illegible]).

Step 10. Retract the margins of the wound and infrahyoid muscles; detach the muscles from the thyroid cartilage; the inferior constrictors to the posterolateral aspects of the larynx are cut; ligate the cricothyroid artery; sever the internal laryngeal nerves where they join the thyrohyoid membrane.

Step 11. If greater exposure is desired the thyrohyoid membrane is incised above the thyroid cartilage. The procedure from here on is determined by the individual requirements. Separation from below is generally preferred.

Step [illegible]. Separate the tracheal stump and larynx from the esophagus by means of blunt dissection accomplished by the use of [illegible] forceps, blunt dissector, Mayo scissors and the fingers. This is an exacting part of the operation and should be done very carefully.

Step 13. Sever the inferior constrictor of the pharynx close to the thyroid cartilage. Detach the larynx from the esophagus at the arytenoid cartilages.

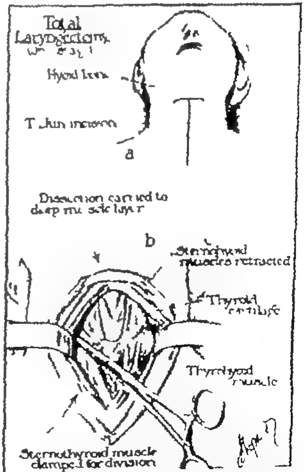


Fig. 285. Total laryngectomy in one stage. T-skin incision. [illegible] of the [illegible] line of the incision to the hyoid bone and [illegible] of sternal [illegible] to the [illegible]. b, The superficial fascia have been divided. [illegible] of the larynx has been begun by [illegible] the [illegible] muscles. The [illegible] depicts the [illegible] of the sternohyoid and thyrohyoid [illegible].

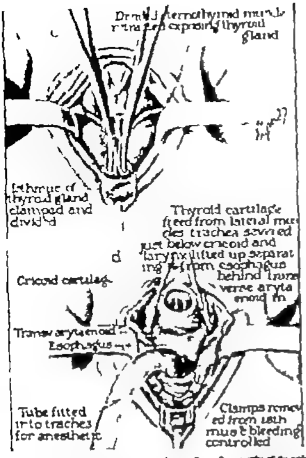


Fig. 485. Total laryngectomy in one step (continued). [illegible]

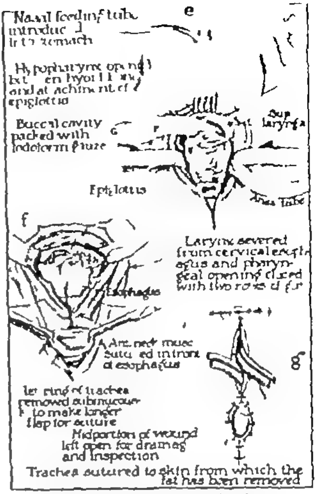


Fig. 485. Total laryngectomy in one step (continued). [illegible] The trachea has been sutured to the skin from which the fat has been removed.

(Fig. 485 f) Divide the pharyngeal mucosa transversely half inch beyond the growth. Divide the thyroid cartilage in front transversely.

Step 14. The epiglottis may be removed with the larynx which is dissected leaving the pharyngeal cavity open.

Fig. 486

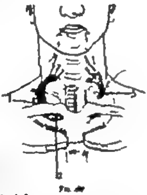


Fig. 487

Fig. 486. Cervical rib.

Fig. 487. [illegible] of cervical rib. [illegible] The arrow points to the [illegible] of the plexus [illegible] the brachial plexus. The dotted line also represents the cervical rib after Coleman.

Step [illegible] Where it is possible to close the wound by suturing, the trachea is fastened to the lower part of the neck. Temporary drains are inserted (Fig. 485 g).

EXCISION OF CERVICAL RIB

Cervical ribs are unilateral or bilateral and are not of the same size. They are joined to the seventh cervical vertebra and in some instances terminate in the neck tissues; in other instances they are joined anteriorly to the first thoracic rib or sternum (Fig. 486). Ordinarily there are no symptoms; however, in some cases the rib presses on the vessels or nerve-trunks passing over it (Fig. 487). If pressure symptoms do not respond to simple measures, surgical intervention becomes necessary. Sometimes the connective tissue which extends beyond the rib is the source of trouble and must be excised.

Anterior Operation

Step [illegible] Approach

(a) Make an incision beginning [illegible] finger's breadth over the clavicle and extending from the sternomastoid to the trapezius, or

(b) Make an oblique incision along the front edge of the trapezius muscle or slightly in front of it, or

(c) Make [illegible] vertical incision over the most prominent part of the swelling.

These incisions permit equal access provided adequate exposure is obtained. [illegible] may be necessary, in some instances, to combine two incisions.

Step 2. Incise the platysma and superficial fascia. Ligate the external jugular vein doubly and divide [illegible] between ligatures. Incise the deeper tissues so as to obtain exposure of the brachial plexus and large vessels. Carefully draw back the vessels and nerves lying over the cervical rib.

Step 3. Detach the rib from its tissues by means of blunt and sharp dissection; carefully avoid the pleura. Extraperiosteal excision of the rib is more difficult to perform than subperiosteal and seems to be somewhat superior. Expose [illegible] small middle part of the rib, divide it near the spine with [illegible] bone forceps, carefully clearing away all sharp spicules adhering to the part left attached to the spine; divide the rib from its frontal attachment and remove. Only the portion of the bone exerting pressure on the nerves and vessels need be excised, in cases where excision of the entire rib appears too difficult.

Step 4. Check bleeding. Effect closure of the wound by means of deep and superficial sutures.

Posterior Operation (Streissler's Method)

Step 1. Make an incision downward and parallel to the spine beginning [illegible] cm. to the side of the spinous processes of the vertebrae and the width of [illegible] hand above the vertebra prominens and terminating the width of [illegible] hand below the vertebra prominens.

Step [illegible] Separate the trapezius, both rhomboids, serratus posterior and splenius; the complexus and transversalis colli are also divided, thus obtaining exposure of the two lower cervical and two upper thoracic vertebrae as well as the junction of the cervical rib and transverse process of the seventh cervical vertebra.

Step 3. Excise the transverse process exposing the neck of the rib, and divide with [illegible] curved elevator avoiding the nerve roots immediately in front of it.

Step 4. Grasp the rib with forceps and detach it as far as possible anteriorly by means of sharp and blunt dissection.

If removal of the rib proves too difficult on account of inadequate exposure, finish the operation through [illegible] front incision. The results, as [illegible] rule, are quite satisfactory.

Comment. Preserve, whenever possible, the posterior supraclavicular nerves; avoid the accessory nerve at the upper end of the wound. When mobilizing the sternomastoid muscle, pull it forward with the external jugular vein. When dividing the deep fascia, secure the transverse cervical vein as it passes over the posterior triangle where it merges with the external jugular vein. Free the posterior belly of the omohyoid muscle, displace it upward. Divide and ligate the transverse cervical artery where it crosses anterior to the brachial plexus. Be sure to identify the phrenic at the lateral margin of the scalenus anterior muscle in front of the scalenus medius. In

palpating the cervical rib through the scalenus medius, divide the muscles over the proximal portion of the rib, detaching them entirely from that structure. The rib is usually divided with its periosteum beyond the transverse process of the cervical vertebra. In clearing the rib forward and downward, free a layer corresponding to Sibson's fascia. Avoid injuring the pleura.

The front end of the cervical rib is generally attached to the first thoracic rib in the area of the scalene tubercle by bone or tissue fibers. To obtain exposure of this junction, carefully draw forward the lowest trunk of the brachial plexus and the subclavian artery. Divide the front junction and remove the rib.

In unusual instances where the rib reaches beyond the scalene tubercle, the rib may be severed at the level of the tubercle, since the front portion is harmless. In cases where pressure exists on the lower portion of the brachial plexus near the middle of the first thoracic rib, a similar procedure is followed. Expose the first rib; clear and remove the portion between the neck of the rib and scalene tubercle.

Control hemorrhage and apply a large pad of wool and a bandage to preclude a hematoma.

REMOVAL OF THE CERVICAL SYMPATHETIC

Anatomic and Practical Considerations. The cervical sympathetic is sometimes included in tumors of the neck; it is frequently compressed by a neoplasm, dilatation of an artery or an abscess. Motor fibers of the involuntary muscles of the orbit and eyelids, vasomotor fibers of the face, neck and head, dilator fibers of the pupil, accelerator fibers of the heart and secretory fibers of the salivary glands are furnished by the cervical sympathetic. Irritation of the cervical sympathetic results in the following conditions: wider opening of the palpebral fissure, exophthalmos, dilatation of the pupils, decreased perspiration, saliva and nasal secretion; the face and neck of the patient appears pale and cold. Its obliteration results in symptoms directly opposite those enumerated above.

Epilepsy, glaucoma and exophthalmic goiter have been indications for the removal of the cervical sympathetic. Jonnesco has been very successful in performing this operation in cases of exophthalmic goiter; he recommends it also in cases of epilepsy, chorea and brain tumor. The cervical sympathetic is situated on the prevertebral fascia back of the carotid sheath and may be removed through an incision in front of the sternomastoid. Directly opposite the transverse processes of the second and third vertebrae appears the superior cervical ganglion, whose branches extend upward near the external and internal carotid arteries, the ascending branch passing through the bony canal along the internal carotid artery at the base of the skull where the carotid and cavernous plexuses develop. The remaining tributaries form a communication with the cranial nerves, the pharyngeal nerves and the superficial cervical cardiac nerve. On the inferior thyroid artery opposite the sixth cervical vertebra appears the middle cervical ganglion; between the neck of the first rib and the transverse process of the seventh cervical vertebra is found the inferior ganglion.

The superior thoracic ganglia of the cervical sympathetic, which are four or five in number, supply also the thoracic viscera, while the inferior, which are seven or eight in number, make up the splanchnic nerves and supply the abdominal viscera through the solar plexus. It should be remembered that the intercostal nerves originating from the spinal cord which correspond with the splanchnics which emerge from the ganglia and the ilio-hypogastric and ilio-inguinal nerves furnish the motor and sensory supply of the wall of the abdomen. Similarly the same portions of the spinal cord furnish the abdominal viscera and their coverings of skin and muscle.

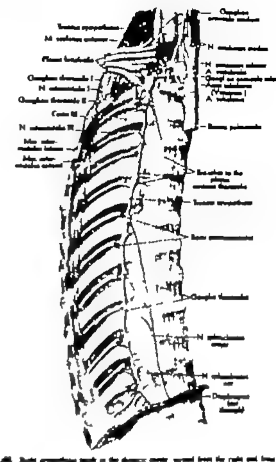


Fig. [illegible]. Right sympathetic trunk in the thoracic cavity, viewed from the right and from in front. (The pleura and fascia endothoracica have been removed. Of the sympathetics only few branches are drawn.)

The same pattern is followed by the nerves to the joints, the same nerve supplying the skin, joints and muscles, hence the sympathetic action of the parts under certain conditions. When a joint is inflamed in order to protect it, the skin becomes very sensitive, and the muscles stiffen making rest imperative. The abdominal muscles behave in the same way in case of inflamed viscera. (Fig. 488.)

Cervical Sympathectomy

Step 1. Make an incision beginning opposite the posterior margin of the mastoid process and continue it downward along the posterior border of the sternomastoid muscle to a point just below the clavicle. Divide the skin, superficial fascia and platysma. Ligate and divide the external jugular vein. *Displace the sternomastoid muscle inward; expose by blunt dissection the common sheath of the carotid vessels* (Fig. [illegible], page 444).

Step [illegible]. Lift the exposed carotid sheath upward and retract it, thus exposing the cervical cord and superior and middle cervical ganglia. Isolate the trunk of the cervical sympathetic near the center of the incision and follow it *up to the superior ganglion.*

Step 3. Divide the communicating branches of the ganglion with scissors. Remove the ganglion with forceps.

Step 4. By making slight traction upon the distal end of the trunk, the cord is traced down to the middle ganglion; remove it in the same manner. Follow *the main trunk of the sympathetic downward behind the clavicle to the inferior ganglion.* Remove it. Exercise care not to injure the spinal accessory nerve and other important nerves and vessels in the vicinity.

Step 5. Unite with catgut sutures the separated muscles. Close the superficial wound.

Comment. *Isolation and resection of the inferior ganglion is the most difficult step in the operation, as the ganglion lies deeply embedded in a special pocket at the base of the neck or even in the thorax, behind the clavicle, against the neck and head of the first rib, between the scalenus anticus and longus colli muscles and just above the pleura. The trunk of the nerve should be used as a guide to the ganglion. It lies sometimes internal to, though rarely external to, the vertebral artery. The ganglion is adherent to the artery and unites it in a meshwork of its efferent and afferent fibers. To reach it, retract the scalenus anticus, the thyroid axis, and the vertebral artery and vein downward and outward; retract the sternomastoid muscle and the carotid sheath with its contents inward and forward. Divide the cellular and aponeurotic tissues covering the vessels and the ganglion. Isolate the ganglion from the vertebral artery externally and from the rib and spine internally. Isolate and divide the afferent and efferent fibers, and remove the ganglion.*

Dangers.

1. Injury to the vertebral artery and vein.
2. Injury to the first intercostal artery or its cervical branch.
3. Injury to the subclavian artery, especially on the left side.
4. *Injury to the pleura.*
5. *Morcellement may become necessary when the ganglion is friable.*

6. Intimate union of the inferior cervical and first thoracic ganglia into one mass, from which a portion must be removed.
7. Injury to the retroclavicular venous plexus.

After the patient recovers from the operation performed on one side, the other side is operated on similarly.

TORTICOLLIS (WRY NECK; CAPUT OBSTIPUM)

There are several surgical methods to cope with this condition.

1. Subcutaneous tenotomy of the sternal and clavicular portions of the sternomastoid. (Fig. 489.) This operation is not much in vogue at

Fig. 489. Torticollis. Subcutaneous tenotomy of the sternal and clavicular portions of the sternomastoid.

Fig. 490. Line of incision for open tenotomy of the sternomastoid.

present, as its favor in the absence of scar, which speaks for it, offsets the inadequacy of the procedure and its accompanying dangers.

2. Open Operation. This consists in dividing the constrictions and all fibrous bands which prevent rectification of the torticollis.
3. Tendon Lengthening.
4. Mikulicz' procedure which consists of excision of the degenerated sternomastoid.

In spasmodic torticollis the following methods may be used:

1. Multiple myotomy (Kocher).
2. Forney's Operation (see below).

Open Tenotomy of the Sternomastoid Muscle

Step [illegible]. The tendon is divided ½ to ¾ inch above the clavicle; this is best accomplished by an oblique incision (Fig. 490). Begin the incision at the outer edge of the sternal attachment of the sternomastoid; the incision should be [illegible] to [illegible] inches in length and should extend upward and outward to the middle of the anterior margin of the clavicular portion of the muscle.

Step [illegible]. *Retract the wound thoroughly and expose both portions of the muscle.*

isolate and divide the attachments under visual guidance. The head of the patient should be rotated toward the sound side, thus putting all contracted structures on tension. These should be carefully divided.

Step 3. Attend to hemostasis. Close the wound. Dress.

Comment. Forcible overcorrection is advised by Lorenz before the patient comes out of the anesthesia. Retain the corrected or overcorrected position by an extension apparatus or by means of a proper dressing (plaster of Paris). Later resort to massage, etc.

Muscle Lengthening

This method is recommended by Turnbull Thomas. The object is to dispense with prolonged and tedious after treatment. No retentive apparatus is used.

Step 1. Make a transverse incision over the lower third of the sternomastoid. Expose the sternomastoid muscle and isolate its lower third. Compare for the degree of shortening on the affected side.

Step 2. Split the affected muscle longitudinally for a distance equal to a little more than half the amount of the shortening. Divide the anterior portion of the muscle transversely at the lower end of the vertical incision. At the upper end of the vertical incision divide the posterior portion of the muscle.

Step 3. Unite the ends of the muscle with chromicized catgut.

Step 4. Close the wound.

Comment. Besides lengthening the muscle, restraining bands should be thoroughly divided.

Mikulicz Operation—Myectomy

In inveterate cases Mikulicz advised excision of the lower two-thirds of the sternomastoid, the upper one-third being preserved to avoid injury to the spinal accessory nerve.

Step 1. Expose and divide the sternal and clavicular portions of the muscle described above under open tenotomy.

Step 2. Grasp the divided ends of the muscle with forceps and pull them downward through the skin wound and while so doing, separate the muscle from its surroundings by thorough, blunt and sharp dissection. Avoid injuring the external jugular vein.

Step 3. When two-thirds of the muscle has been isolated, section and remove it.

Step 4. Attend to hemostasis. Divide all accessible cicatricial bands and close the wound. Dress. There is no need for postoperative orthopedic care.

Comment. Only one-third of the muscle is removed by Brown. This operation should be reserved for severe or recurrent cases where all other methods have failed. The principle disadvantage of the operation is cosmetic disfiguration of the neck.

SPASMODIC TORTICOLLIS

John M. T. Finney and Walter Hughson made a study of thirty-two cases of spasmodic torticollis. None were the common congenital and other acquired forms.

The disease derives its name from a sudden convulsive movement or spasm

Annals of Surgery, 1925

of one or more muscles or groups of muscles that move the head on the body. Not infrequently when one muscle or group of muscles—those primarily involved—are put out of commission by operation, the affection immediately manifests itself in an adjacent set of muscles, or may even involve the opposite side. This fact adds greatly to the uncertainty hitherto existing. Either for this reason or because incomplete operations have been performed, a comparatively large proportion of cases have required repeated operations before a cure has been ef-

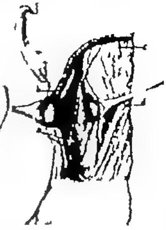


Fig. 430. Fig. 431.

Fig. 430. Incision. Lower limb level of angle of jaw, upper ... below occipital protuberance. (Courtesy of Dr. J. M. T. Finney.)

Fig. 431. ... spinal accessory nerve ... lesser occipital nerve ... greater occipital nerve ... third cervical nerve ... are taken ... and subcutaneous tissue have been turned back. (Courtesy of Dr. J. M. T. Finney.)

fected. In a fairly large proportion of the cases moderate improvement was not attained for a considerable period—from six months to two or three years.

Finney Operation for Spasmodic Torticollis

Step 1. Make an incision along the posterior border of the sternomastoid muscle (Fig. 430), beginning at a point two finger-breadths below the level of the angle of the jaw and continuing upward along the edge of the muscle to a point about the level of the lobe of the ear, then curving over toward the midline to a point about two finger-breadths below the occipital protuberance, thence curved across the midline, following the same general direction as just described, in reverse order. When completed, the incision is in the form of an inverted "U."

Step 2. Reflect the flap of skin and subcutaneous tissue, taking care to identify and avoid the lesser occipital nerve which is quite superficial and lies along the posterior border of the sternomastoid muscle in its upper half. Having exposed and identified this nerve, follow it down to the point where it emerges from behind the posterior border of the sternomastoid muscle (Fig. 431).

Step 3. By retracting the sternomastoid muscle, the anterior divisions of the second, third and fourth cervical nerves now come into view together with the chain of deep cervical lymph nodes.

Fig. 432. Fig. 433.

Fig. 432. Spinal accessory nerve ... lesser occipital nerve ... greater occipital nerve ... third cervical nerve. Splenius and trapezius muscles have been divided and turned back.

Fig. 433. Lesser occipital nerve ... greater occipital nerve ... third cervical nerve ... suboccipital nerve ... branch of venous plexus. All posterior muscles have been divided and turned back, exposing the suboccipital triangle. (Courtesy of Dr. J. M. T. Finney.)

Step 4. A little farther in front of the nerve plexus, and consequently a little deeper in the wound, will be found the trunk of the spinal accessory nerve at the point where it emerges from the body of the muscle. The nerve having once been definitely identified (and here, as with all other nerve trunks involved, direct stimulation with a bipolar electrode makes the identification absolute) it can be resected at any point desired. No effort should be made to save the sensory branches of these nerves as, in Thomas' operation, both efferent and afferent pathways should be interrupted.

Step 5. Search should next be made for the great occipital nerve where it emerges through the fibers of the splenius, about one cm. from the midline

and just beneath the skin incision. Having identified this nerve, divide transversely at this point the trapezius and splenius muscles (Fig. 433) exposing the fibers of the complexus which is easily recognized.

Step 6. The fibers of this muscle are divided in turn through its whole thickness in the same plane as the skin incision, and it is then reflected backward in the same way, care being taken all the while to preserve the great occipital nerve which lies immediately below it. This exposes the two recti muscles (major and minor) and the superior and inferior obliques (Fig. 433), each of which can be distinguished by the direction of its fibers and their common point of origin.

Step 7. The trunk of the great occipital nerve should then be traced down to the point where it emerges from the vertebral foramen at the lower border of the inferior oblique muscle. At this point will be found its anastomosis with the suboccipital nerve running across the body of the muscle to the point where it is given off from the first cervical nerve in the suboccipital triangle. The great occipital nerve should be resected below the point of anastomosis with the suboccipital nerve.

Step 8. The suboccipital nerve can be traced out in the suboccipital triangle as it emerges between the vertebral artery lying deep in the triangle and the upper border of the inferior oblique muscle. Its branches to the recti muscles and the superior and inferior oblique muscles are given off here and the main trunk of the nerve can be readily resected at this point. Care should be taken not to injure the vertebral artery which can be identified as it lies on the floor of the triangle.

Step 9. The splenius and complexus muscles should be retracted sufficiently to allow the exposure of the third cervical nerve where it emerges deeper beneath below the great occipital. At the level of the second and third cervical nerves is located a venous plexus of considerable size which may give rise to troublesome bleeding if care is not taken to avoid or control it, which, however, can be readily done. The third cervical nerve should be resected where it emerges from the vertebral foramen as it supplies fibers to the overlying muscles (splenius, trapezius and complexus).

Step 10. After the trunks of the upper three cervical nerves have been resected as described, the muscles may be replaced, layer by layer, and held in place by a few stitches, and the wound closed in the usual manner. In the earlier operations portions of these muscles were excised, but subsequent experience has shown that with complete resection of the nerve-supply this rather mutilating procedure may be omitted. Formerly a drain, consisting of a small piece of protective, was always inserted at each corner of the incision, but with adequate hemostasis this is probably unnecessary.

At one time Finney applied a plaster of Paris bandage reinforced with wooden splints but this added greatly to the patient's discomfort and so was discontinued in favor of the ordinary gauze dressing and soft bandage, reinforced with light wooden compression-splints if desired. Notwithstanding the great extent of the wound, he has found the healing to be uniformly satisfactory and the resulting disability surprisingly slight.

The Sparling-Jelsma Technic in Spasmodic Torticollis

R. Glenn Spurling and Franklin Jelsma[1] point out:

While it is true that there are many reports in the literature concerning the treatment of psychoanalyses and medical measures, such reports have been, on the whole, unconvincing.

There are cases in which the spasmodic contractures seem to be sharply limited to one sternocleidomastoid muscle or perhaps one sternocleidomastoid and one trapezius muscle. While cases of this sort are rare, yet they do occur and [illegible] unilateral section of the spinal accessory nerve may effect [illegible] cure. Judging from the reports of some authors, it would seem that improvement is likely to be temporary because the spasmodic contractures soon develop on the opposite side or in the other muscles of the neck on the same side.

Spurling and Jelsma believe that all of the muscles of the neck are involved in severe cases; and nothing short of the radical intervention will suffice to relieve the symptoms. This attitude is the one held by the majority of surgeons who have written in recent years upon the treatment of this malady. The Keen operation forms the basis of treatment now generally employed. Finney and Hughson in 19[illegible] described an operation which is [illegible] great improvement upon the original Keen procedure. I[illegible] consists of sectioning the first three cervical nerves and the spinal accessory nerve bilaterally, also the division of most of the posterior neck muscles attached to the occipital bone. Their results in [illegible] series of thirty-two cases were highly satisfactory.

In 19[illegible], M[illegible] Kenzie, from Cushing's clinic, reported the intradural section of the first, second and third cervical nerves and the spinal accessory nerve on one side for the relief of [illegible] severe case of spasmodic torticollis. In this report, [illegible] statement by Dr. Cushing indicated that as early as 19[illegible] he had performed an intradural section of the first and second cervical nerves in the treatment of [illegible] case of this disease.

Coleman, in 19[illegible], reported the first case in which the first four cervical posterior roots on both sides were sectioned intradurally. He resected the spinal accessory nerves in the neck at the secondary operation. The result in his case was highly satisfactory.

Since M[illegible] Kenzie's report appeared, neurosurgeons generally have adopted the intraspinal operation as the method of choice. The result seems more satisfactory than that by any other procedure heretofore employed.

The only variation in the technic of the intradural operation is that some authors advise cutting the spinal portion of the accessory nerve intradurally while others prefer to section the nerve in the neck. Spurling and Jelsma believe that the operation can be performed safely by division of all the nerves, viz., the first three cervical anterior and posterior roots and the spinal portion of the accessory nerve intradurally. Thus, the entire procedure can be completed in one sitting through one operative incision. I[illegible] is unnecessary to remove [illegible] part of the occipital bone as originally advised by McKenzie in order to section the accessory nerve. Inasmuch as

[1] South. Med. Jour., March, 19[illegible].

we are concerned only with the spinal portion of the nerve, it can be divided easily through the dural incision at the level of the foramen magnum. It is unnecessary to section the cerebral portion of the accessory nerve, since it plays no part in the disease.

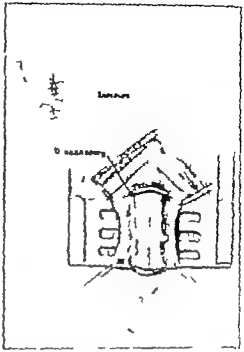


Fig. [illegible]. Spurling-Jelsma operation. [illegible] [illegible]

Step 1. Make [illegible] midline incision from the occipital protuberance to the spinous process of the fifth cervical vertebra. Free the muscles and periosteum from the spinous processes and the base of the occipital bone. Remove the laminae of the upper three cervical vertebrae.

Step 2. Open the dura mater in the midline over the first three cervical segments

and extend the incision upward to the rim of the foramen magnum, being careful to avoid the circular dural sinus.

Step 3. Identify and section the posterior and anterior roots of the first three cervical nerves. (Often the posterior root of the first cervical nerve is absent.) Identify the filaments of the spinal portion of the eleventh nerve between the posterior and anterior cervical roots. Where these filaments unite to form the spinal part of the accessory nerve, [illegible] small artery is seen. Apply silver clips to occlude the artery and nerve trunk before cutting the nerve (Fig. [illegible]).

Step 4. Close the dura and neck muscles with layers of interrupted silk sutures. Immobilize the patient's head for the first few days with sandbags. After this the patient should turn his head from side to side gradually active to support [illegible] his sitting in bed and after two weeks start active motion of the neck muscles.

Spurling and Jelsma comment as follows:

"Convalescence in the two cases which we have treated by this method has been rapid and uneventful. Spasmodic contractures disappeared immediately following the operation. At first, the patient will complain of considerable difficulty in supporting the head. In both instances the patients have been able to walk around with little or no discomfort after four weeks. In the first patient, upon whom we operated eight months ago, the weakness and fatigue of the neck muscles have entirely disappeared, although he still recognizes the fact that movements of the head and neck are limited considerably.

"The choice of which radical operation should be used in the treatment of severe spasmodic torticollis seems to us to be one of individual preference, because both the Finney operation and the intradural operation seek to accomplish the same end. We believe that the intradural operation is by far the simpler procedure, provided the operator is accustomed to intraspinal operations. The mortality for either operation should be practically nil. It seems to us that there is more likelihood of missing important nerve roots by the Finney operation than by the intradural approach. There again, such [illegible] contingency would depend largely upon the skill and experience of the individual operator. When the Finney operation is employed there is always the possibility of regeneration of the nerves after section outside the spinal cord. This possibility does not obtain when the nerves are sectioned intradurally."

CYSTS AND TUMORS OF THE NECK

REMOVAL OF TUMORS OF THE NECK IN GENERAL

Removal of tumors of the neck requires mature surgical judgment and experience. It [illegible] beset with many pitfalls and dangers. Beginners and those of limited experience and dangerous ground in undertaking removal of tumors of the neck.

"Block dissection[illegible] of the tumor and regional lymph nodes is the goal. In other words, an attempt is made to dissect out the neoplasm and its lymph apparatus en bloc (Fig. [illegible])."

Dangers of the Operation.

Hemorrhage. Careful dissection and ligation of vessels as encountered will do much to minimize bleeding.

2. Air Embolism. W[illegible] must remember that during inspiration the blood in the cervical veins [illegible] under negative pressure and that, under these circumstances, if [illegible] vein is opened, air may be sucked into the vessel and through it into the heart with fatal results. This may be obviated by painstak-

Fig. [illegible]. Lymphosarcoma of glands of [illegible] [illegible] (From Author's [illegible])

ing technic and prompt action should the accident occur (tilt table; pressure).

Precautions.

Always work with ample exposure and good illumination.

Keep the wound moist. Should the slightest "hissing" sound be heard, promptly press the finger against the course of [illegible] point nearer the heart than is the wounded vein. "Hissing" means air has found its way into the vessel, or injury to the pleura [illegible] which [illegible] these air columns into the wound.

The late John B. Murphy placed [illegible] small pack of gauze to which thread was attached to keep it from being lost, under the sternal attachment of the sternomastoid muscle. The object was to exert pressure to keep the cervical veins full, thus making the veins visibly prominent and preventing the danger of negative pressure. This step is of great value.

Leave impossible cases alone. (Fig. [illegible].) (See also air embolism.)

3. The blunt dissection in preference to sharp division of the tissues.

Keep! look! and touch! before you divide any structure about which you are in doubt.

5. Secure hemostasis as you go along. Respect tissues: treat them kindly; don't tear.

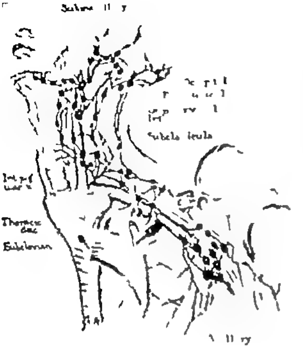


Fig. Distribution of the lymphatics in the neck.

If, in spite of all precautions, air has been sucked into a vein, Bonde advises packing the wound in the neck loosely; do not apply forceps to the vein or forcibly compress the chest during the succeeding expirations; and do not lower the head and shoulders of the patient.

6. Avoid injury to the thoracic duct. When the duct has been injured, little clear fluid (chyle) is seen escaping. Usually such leakage are not

fraught with danger. Lexer points out that the discharge will continue for about three weeks. It usually yields to compression and proper treatment. During this period patients lose considerable weight.

7. Avoid injury to important nerves: the spinal accessory, vagus, phrenic, recurrent laryngeal or cervical sympathetic nerves.

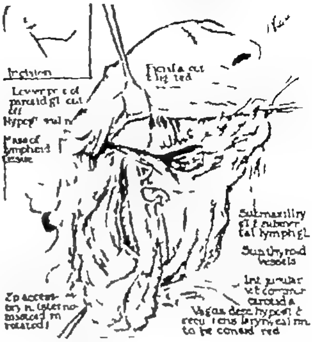


Fig. Block dissection of the lymph nodes of the neck, submaxillary and submental regions.

Where the affected lymph nodes are few or not adherent, the operation is simple. Under such circumstances, make an incision over the tumor and shell out by blunt dissection through the incision.

Step 1. Drape the scalp with ... gauze or rubber cap to keep the hair out of the way. Support the patient's shoulders and turn his head to the opposite side.

Step 2. Make an oblique incision along the sternomastoid muscle beginning at the mastoid process and ending near the sternoclavicular articulation. Expose

the external jugular vein and divide it between two ligatures (Fig. ...). Keep the field of operation constantly free from blood.

Step 3. Dissect the skin laterally from the subjacent tissues anterior and posterior to the incision and retract it. If necessary, make another incision beginning at the lower end of the oblique incision and continue it outward, parallel to and close to the clavicle. A variety of incisions have been recommended for block dissection in this region. The experienced surgeon will plan the incision to meet the requirements of the case.

Lay bare the sternomastoid muscle and liberate it from its surroundings through its entire extent. Divide the deep cervical fascia at the upper border of the clavicle from the symphysis menti to the mastoid process and downward across the hyoid bone to the sternal portion of the sternomastoid muscle. Ligate and divide the sternomastoid muscle.

When the internal jugular vein is to be ligated and divided, do so just above the clavicle. Look for the omohyoid muscle which has been exposed and find the internal jugular vein beneath. Dissect the vein out of its sheath. Do not injure the internal carotid artery or vagus nerve.

Note the point of exit of the superficial cervical nerves at the posterior edge of the muscle. These nerves are of considerable size and with careful dissection are readily identified. Identify the spinal accessory nerve as it emerges from behind the sternomastoid muscle. This nerve enters the muscle about two inches below the tip of the mastoid process, after passing over the prominent transverse process of the atlas. It is important to preserve this nerve in young individuals. Clayton Parker has shown that if the nerve is severed, drooping of the shoulder and scoliosis result.

Step 4. Dissect out the packet of fascia which enfolds the carotid artery, the internal jugular vein, and the vagus nerve. Once exposed, protection of these important structures from trauma is facilitated. Clean out the supraclavicular space. Ligate the transverse cervical artery here. Look out for the thoracic duct. If divided, tie here with smooth (see above). Respect the phrenic nerve and cupola of the pleura at the apex of the lung.

Step 5. Systematically remove the diseased lymph nodes. Begin the dissection near the lower end of the wound and by the side of the carotid packet. This is not difficult to accomplish. No blind work is permissible. If these important structures are not carefully exposed and protected at an early stage in the operation, thorough removal of the nodes will become a difficult and dangerous task.

Step 6. Repair the wound in the cervical fascia by suture. Attend to thorough hemostasis. Unite the platysma. In careless suturing of the fascia an ugly scar will result because of stretching of the skin. Drain at the lower angle of the wound.

Step 7. Close the skin wound with interrupted sutures or Michel clips. Apply voluminous dressing.

Comment. If the operation is performed for tuberculous lymph-nodes, there may be ruptured and caseous material to escape. In such case, wipe the escaped material away. It is good practice to swab the remnants of the caseous material from the ruptured gland, subsequently mopping the part swabbed with liquid carbolic acid.

In dissecting the nodes for malignant disease look for the external maxillary artery in the upper part of the dissection and identify it where it enters the groove in the submaxillary gland. Clamp and doubly ligate it. Remove the submaxillary gland with its nodes and ligate its duct close to the floor of the mouth. Include the submental nodes in the dissection. When working along the horizontal ramus of the mandible a number of facial veins will also call for division and ligature. Along the submental region great care should be exercised not to leave any nodes behind. Crile insists, and justly so, that complete block dissection of the neck in all cases of carcinoma of the tongue is of cardinal importance. To this must be added complete removal of the lateral structures surrounding the lymph nodes and complete removal of the sternomastoid muscle. Block dissection is done with greater facility when the sternomastoid is removed together with the anterior jugular vein and lymph structures. In some cases removal of the primary growth with the cautery instead of the scalpel is of decided value. In working in the submaxillary region, do not injure the hypoglossal nerve.

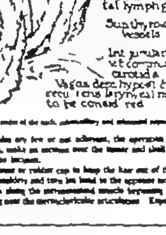


Fig. Tuberculous lymphoma of the glands of the neck.

TUBERCULOUS CERVICAL ADENITIS

Much surgery has been done in this class of cases heretofore. At present the scalpel has yielded to x-ray radium and heliotherapy with much more gratifying results than before, particularly is this true in tuberculous lymphadenitis, while Hodgkins disease is, it needs no emphasis, not amenable to surgical interference (Figs. ... and ..., p. ...).

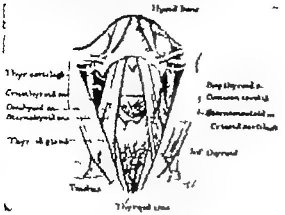
The surgeon of today rarely subjects cases of tuberculous lymphadenitis to operation without having first given the measures enumerated above a trial. If block dissection should, for some reason, be decided upon, the technic of that operation will be found elsewhere in this chapter.

THYROGLOSSAL CYSTS AND FISTULAE

These congenital conditions are usually found in one of three situations (Fig. ...):

1. Between the foramen caecum of the tongue and the hyoid bone (Fig. ...);
2. Between the hyoid and larynx;
3. Below the larynx overlying the trachea.

[illegible]



[illegible]

[illegible]

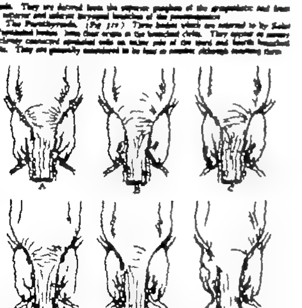
[illegible]

Blood Supply. [illegible]

Nerve Supply. [illegible]

[illegible]

The Parathyroids. [illegible]



[illegible]

[illegible]

Preoperative Medication

[illegible]

period of remission. The mortality of resection operations done during the period of remission has been reduced almost to nil, and other operations are rarely necessary. If thyroid resection is not done at this favorable time of remission, the patient often relapses into a state of clinical exacerbation in the course of one to two or even three months. A condition of uncontrollable hyperthyroidism may then result. Similarly, exacerbations may follow upon the administration of iodine even in small doses, over a prolonged period.

"The hyperplastic thyroid gland in the phase of exacerbation following a previous period of treatment with iodine becomes relatively insensitive or refractory to the further administration of iodine. The preoperative treatment with iodine

FIG. 593. Pronounced Graves' disease.

does not protect the iodized patient with toxic adenoma or Graves' disease in any way comparable to the protection afforded the patient not previously so treated. The patient suffering with an acute exacerbation following prolonged use of iodine may be a dangerous operative risk whether iodine is given preoperatively or not. It is particularly in these circumstances that recourse must be had to multiple operations such as preliminary ligation and single lobectomies to diminish the increased risk involved in a primary double lobectomy.

"Iodine has little effect in controlling postoperative hyperthyroidism. There is no evidence that the postoperative administration of iodine reduces the incidence of recurrent hyperthyroidism. The spontaneous hyperthyroid crisis occurring occasionally in the course of severe Graves' disease may be effectively controlled by large doses of iodine given either orally or intravenously. When the crisis occurs

as a result of the incorrect use of iodine, the further administration of iodine, even in large amounts, is ineffectual and a fatal outcome may ensue."

THYROIDECTOMY

A uniform technic does not exist. Every surgeon puts into his work the seal of his own individuality; consequently divergence of details will always be found. Fundamental differences, however, do not exist any longer. (André Crotti.) (Figs. 593-594-595-596-597.)

FIG. 594. FIG. 595.

FIG. 594. Simple adenoma of the thyroid causing tracheal obstruction.

FIG. 595. Same patient after operation. (Author's Service, Cook County Hospital.)

Preanesthetic Medication

One-half to one hour before the operation, administer subcutaneously ¼ gr. of morphine and 1/150 gr. of atropine sulphate.

Local Anesthesia

In selected cases properly executed, local anesthesia is excellent. The advantages of local anesthesia are many. Among these may be mentioned: (a) the deleterious effects of the inhaled anesthetic on the lungs, kidneys and liver are avoided; (b) the recurrent laryngeal nerves are safeguarded; (c) the increased excitement, and consequently added strain, incident to taking and coming out of the anesthesia is avoided; (d) a more leisurely preparation of the field of operation and freedom from worry about the anesthetic during the operation is provided.

Many surgeons prefer this method to others (Kocher, DeQuervain, Beck, Bahn, Johnsley, Crile). Numerous factors are to be considered in the successful execution of local anesthesia, viz.: (a) proper selection of the patient; (b) thorough knowledge of the surgical anatomy of the parts concerned in the operation; (c) the personality of the surgeon and his ability to quiet the patient (think

of the unstable nervous mechanism of the thyrotoxic patient). We follow the teachings of Crile and "steal" the thyroid from the patient before whom operation

FIG. 596. Patient, from whom thyroid [illegible] was removed [illegible] with [illegible] operation.

FIG. 597. [illegible] thyroid [illegible] both lobes and isthmus [illegible] removed [illegible] (Author's Service, Cook County Hospital.)

tion is never discussed and who is unaware of the date set for the ordeal. Each day for a few days prior to the operation, give the patient a hypodermic injection

of sterile water; [illegible] take him to the operating room where a [illegible] anesthesia is made by allowing the patient to inhale a few whiffs of nitrous oxide-oxygen.

I have experimented with other drugs recommended but always returned to novocaine in ½ per cent solution. About 5 ounces can be used with safety provided the solution is made up fresh and is thoroughly aseptic. Some surgeons add adrenalin to the novocaine solution. Let it be recalled that many thyrotoxic patients are supersensitive to adrenalin (Goetsch test). Yet, from a practical point of view the amount of adrenalin used is so small that its deleterious effects are negligible. Its advantage is that it delays absorption of the novocaine and hence

FIG. 598. FIG. 599.

FIG. 598. Blocking of the superior laryngeal nerve. [illegible] laryngeal branch, [illegible] laryngeal branch, [illegible] laryngeal nerve. This nerve does not require [illegible].

FIG. 599. Local anesthesia in thyroidectomy. Line of infiltration in making Kocher's [illegible] in thyroidectomy.

prolongs the time of anesthesia. We add four drops of a [illegible] adrenalin solution to every 100 cc. (3 oz.) of solution. Never exceed [illegible] Gm. ([illegible] gr.) of novocaine crystals in the course of the operation. This amount of novocaine is present in 100 cc. (about 6 oz.) of the ½ per cent solution.

Precaution. Avoid entering a vein with the injecting needle. After the introduction of the needle into the tissues, draw the piston of the syringe a little back and note if blood is aspirated into the glass barrel of the syringe. If none appears, inject the anesthetic solution.

SUPERFICIAL NERVE BLOCKING

This consists of blocking the cutaneous nerve trunks at their exit at a point corresponding to about the middle of the anterior border of the sternomastoid muscle (Figs. 598-599-600-[illegible]).

Ten to twenty cc. of ½ to [illegible] per cent solution of novocaine are injected [illegible] at the point shown in the illustration. (Fig. 599.) Here

the supra-clavicular and great auricular nerves emerge. The skin and subcutaneous tissues become completely anesthetized but the deeper structures remain unaffected.

[illegible] wheal first and successively infiltrate the tissues along the line indicated.

Pass the needle vertically through the skin and fascia at the point illustrated when [illegible] sense of release is felt after the point of the needle has penetrated the fascia and the surgeon has assured himself that he did not enter [illegible] vein (by withdrawing the piston of the syringe as outlined previously) the injection is made.

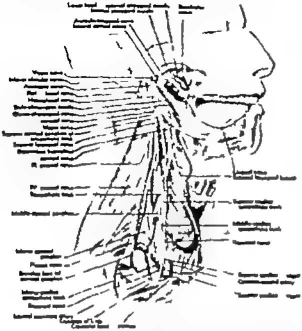


Fig. [illegible]. Deep dissection of right side of head and neck, showing lingual, glosso-pharyngeal, vagus and hypoglossal nerves and sympathetic trunk. [illegible]

Do not permit the needle to advance farther lest deeper structures be jeopardized. It is for that reason that some surgeons limit the injection to bilateral subcutaneous infiltration in [illegible] line along the posterior border of the sternomastoid muscle. This reaches the nerves as they emerge through the fascia, is [illegible] simpler procedure, and is preferred by many.

The next step is to inject the subcutaneous and subfascial area of the skin incision (Figs. [illegible]).

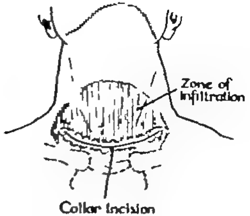


Fig. [illegible]. Infiltration anesthesia in thyroidectomy.

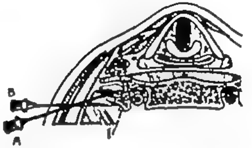


Fig. [illegible]. Nerve blocking in thyroidectomy. [illegible]

Comment. Bilateral injection of the nerve plexus produces the most complete anesthesia, but is attended by the risk of bilateral blocking of the pneumogastric, sympathetics and phrenic nerves. Fatalities have been reported as the result of such accidents.

BLOCKING THE CERVICAL PLEXUS

This consists of injecting the points of junction of the second, third and fourth roots of the cervical nerves at their points of exit from the intervertebral foramina in front of the transverse processes (Figs. [illegible]).

[illegible] and [illegible]'s Paravertebral Nerve Block. [illegible] modification of this method is as follows.

Fig. [illegible]. Schematic diagram of [illegible] section of [illegible] larynx. [illegible]

Draw [illegible] line extending from the anterior border of the mastoid process to the clavicle. This crosses Chassaignac's tubercle. Mark the point of junction of the first [illegible] with the second [illegible] of this line. Practically this point corresponds to the level of the upper border of the thyroid cartilage. It is at this point that the needle is introduced and passed forward until the transverse process of the third cervical vertebra is felt. Withdraw the needle slightly and reintroduce it about [illegible] cm. or more in front of the transverse process (Fig. [illegible]). Make sure that no vessel has been entered. Deposit [illegible] cc. of [illegible] per cent solution of novocaine. Withdraw the needle again for [illegible] short distance and inject the same amount of novocaine in front of the transverse process of the fourth cervical vertebra. DeQuervain admonishes the exercise of the greatest possible care to avoid inadvertently injecting the vertebral artery or vein which when entered

may be followed by serious consequences or even death. If properly performed, complete anesthesia of both superficial and deep tissues result in about [illegible]

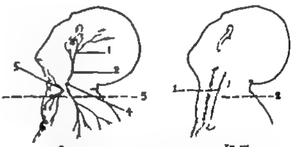


Fig. [illegible]. Fig. [illegible].

[illegible]

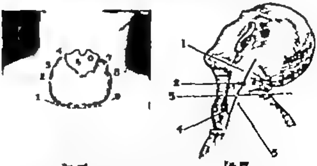


Fig. [illegible]. Fig. [illegible].

Fig. [illegible]. Infiltration anesthesia in thyroidectomy (modified from [illegible]). [illegible]

Fig. [illegible]. [illegible]

[illegible]. Only one side should be blocked. Anesthesia on the other side is brought about by peripheral blocking.

INJECTION OF THE PARATHYROID SPACE

This is also not free from hazards and should be carried out with extreme caution.

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Anesthesia for block dissection of the neck. A, point of entry of needles for blocking the cervical plexus.

Fig. [illegible]. [illegible]

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Paravertebral injection (after [illegible]). [illegible] Second cervical root. [illegible] Third cervical root. [illegible] Fourth cervical root. [illegible] Phrenic nerve. [illegible]

Fig. [illegible]. Injection of the parathyroid space.

In this procedure after the site for the collar incision has been determined and after the [illegible] have been [illegible] the parathyroid spaces are infiltrated as shown in Figs. [illegible]. No solution is injected into the thyroid itself because it is

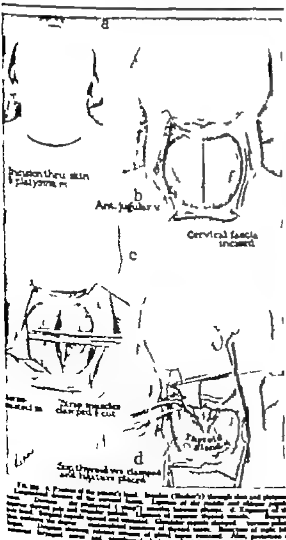


Fig. [illegible]. [illegible]

not sensitive. Some degree of sensitivity is encountered at the upper and lower poles. Painstaking injection is [illegible] here. Crile injects some novocaine-adrenalin solution into the surgical capsule of the thyroid before the goiter is [illegible] since this maneuver is very painful. This holds equally true for the regions about the trachea and esophagus and posterior surface of the thyroid, always keeping in mind the "danger zone." The isthmus is anesthetized by injecting the solution above, below and behind it.

Fig. [illegible]. Thyroidectomy. Arrangement of [illegible] for removal of the thyroid. [illegible]

Operation

Do not begin to operate immediately after injection of the anesthetic is made but allow about ten minutes to elapse. Keep within the limits of the infiltrated area where repeated infiltration has been resorted to.

Position of the Patient. Adjust the patient on the operating table in such manner that there is [illegible] inclines from head to foot. This lessens congestion in the field of operation. Elevate the shoulders on [illegible]. Extend the head; this renders the operative field prominent. Separate the face of the patient from the neck by [illegible] appropriately draped. (Fig. [illegible].)

Step [illegible] (Fig. [illegible].) Make [illegible] collar incision (Kocher) slightly curved, its concavity directed upward. It should be [illegible] above the [illegible]. It varies in length with the size of the goiter. Let the incision correspond to [illegible] natural creases of the skin. If you want to avoid ugly scars, dissect the lower skin flap free so that it can be retracted without tension.

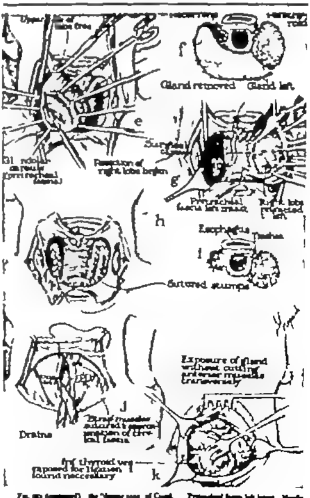


Fig. [illegible] (continued). [illegible] the "danger zone" of Crile. [illegible]

Step 2. (Fig. 533b.) Divide and retract the subcutaneous tissues and platysma. Dissect the upper flap as high as the thyroid cartilage, the lower flap as low as the jugulum. Grasp and ligate small vessels as they present themselves. Divide the median and oblique jugular veins and, if necessary, treat the external jugular veins similarly. Drape and retract the flaps.

Step 3. Incise the cervical fascia vertically in the midline from the thyroid cartilage to the episternal notch, dividing the prethyroid muscles longitudinally. Introduce a finger under the muscles and separate them as far as possible in every direction from the subjacent structures. In so doing, direct the dissecting finger against the posterior surface of the muscles. This is for the purpose of avoiding injury to the veins in this situation. We are now in the musculo-capsular space.

Step 4. If the gland to be resected is of moderate size and no operative difficulties are expected at this stage, the prethyroid muscles are simply separated with the fingers through the longitudinal median incision and are then simply retracted. In most instances this suffices. However, if the surgeon is not very experienced and sufficient space is desirable, it is safest to divide the muscles transversely (Fig. 533c). While it is better to do this step through a longitudinal opening, it is best in most cases to play safe. The muscles are divided at their upper end. The branches of the ansa hypoglossi, which supply the prethyroid muscles, enter the muscles in the lower part of the neck, so that if the nerve supply is to be preserved, the division of the muscles should be as high as possible. Another reason for dividing the muscles high is that after they are sutured again, the scar lies at a higher level than the scar in the skin. The sternohyoid and sternocleidomastoid muscles are incised only when absolutely necessary.

Step 5. The surgical capsule having been divided, the glandular capsule is now in view. It is essential to avoid overlooking the proper line of cleavage. The operation must now be continued in the surgical space. If this precaution is not observed, bungling instead of good surgery will result. Separate the lobe to be resected from its connections with the surgical capsule by blunt dissection with the finger. Retract the surgical capsule thoroughly but not too far posteriorly (parathyroid bodies). Respect the "danger zone" (region of the lower pole: parathyroids and recurrent laryngeal nerve). The middle thyroid veins are often encountered now. These must be doubly ligated and divided. Inadvertent tearing of these veins will flood the operative field with blood and will disturb the inexperienced considerably.

Step 6. Delivery of the thyroid lobe. Gently lift the lobe forward with two fingers introduced into the surgical space. Delivery with instruments may injure the large veins under the glandular capsule and cause undesirable bleeding. When by reason of inflammation or preoperative irradiation there are adhesions between the two capsules, luxation of the lobe will be correspondingly difficult. Forcible delivery may result in alarming hemorrhage. Under such conditions it is safer to resect the gland in situ.

Step 7. Free the upper pole from the surrounding structures. Guard the carotid sheath in so doing. Doubly ligate and divide the superior thyroid pedicle carrying the vessels. (Fig. 533d.) For safety place another ligature above the first. Leave the ends of the ligatures long for the time being. Separate

the superior pole from its attachments to the larynx. Work your way downward around the (Fig. 533e) inferior pole. Occasionally difficulties are encountered if the upper pole extends high up into the neck or encroaches upon the larynx and esophagus. It must then be carefully and thoroughly resected. Remember it is safer to include in the ligature of the superior thyroid vessels a small knob of thyroid tissue than take a chance of the artery slipping out of the ligature.

Step 8. Ligation of the inferior thyroid artery. This is accomplished at a point internal to the carotid sheath. In so doing displace the thyroid lobe inward and upward and the carotid sheath outward. The inferior thyroid artery will usually be found about the junction of the middle with the lower third of the lateral lobe. Only the anterior branch of the artery is ligated and divided. The posterior branch is left undisturbed for nutrition of the remaining thyroid tissue (Fig. 533k).

Step 9. Map out the degree of resection to be accomplished. (Fig. 533f.) The procedure is a transglandular one and is accomplished from above downward. Apply hemostats to the glandular capsule all along the line of proposed resection. Divide the glandular capsule and resect the lobe until the region of the isthmus is reached. Only a thin layer of thyroid tissue is left along the posterior border of the resected gland. This is to be particularly observed in the "danger zone" (recurrent laryngeal, parathyroids). (Fig. 533h, l.) If a thyroidea ima is present, it is ligated. Great care is to be exercised not to disturb the connective tissue covering the larynx and trachea (pretracheal fascia) lest the recurrent fibers coursing here be included in ligatures and subjected to undue irritation (Fig. 533i).

Step 10. Resect the isthmus. Introduce a curved artery forceps between the isthmus and the trachea from below upward and separate these structures. The isthmus may now be divided between two clamps. In dividing the isthmus and lower lobe in this situation, bleeding from the superior communicating veins may be encountered. Clamp and ligate these vessels.

Step 11. If both lobes are to be resected the procedure is to be repeated on the opposite side. Resection may proceed from within outward or vice versa. (Fig. 533m.)

Step 12. If a pyramidal lobe be present, dissect it out from below upward. Remove it thoroughly. If not, compensatory hypertrophy may result and cause conspicuous bulges in the neck.

Step 13. Survey the field of operation. Hemostasis must be perfect. Residual oozing is usually controlled by hot compresses.

Step 14. Examine the superior mediastinum for the possible presence of an enlarged thymus. If found, remove it (see Thymectomy).

Step 15. Resuture the prethyroid muscles and the cervical fascia (Fig. 533j).

Step 16. In thyrotoxic goiters drain for a day or two with a Penrose drain. Otherwise drainage is unnecessary.

Step 17. Resuture the platysma. If not resutured, spreading of the scar may result by reason of traction of this muscle on the edges of the skin incision.

Before proceeding to close the wound in the neck, flexion of the head will often reveal the presence of bleeding. Again, hemostasis must be perfect. Place the head in the normal position.

If the operation has been performed under local anesthesia, ask the patient to cough or speak. This will disclose whether or not the recurrent nerve has been injured or whether an annoying ligature is present. If the gland surfaces have not been approximated the posterior surface of the strap muscles may be sutured directly to the thyroid tissue.

Step 18. Close the skin with metal clips, Pagenstecher linen or horsehair. A subcuticular suture may also be used.

Intraglandular Enucleation

This consists of the enucleation of one or more nodes or cysts from the thyroid substance (Fig. 534).

Step 1. The extent of the skin incision depends upon the extent of the tumor to be enucleated. Primary ligation of principal vessels is unnecessary.

Step 2. Blunt dissection of the tumor is accomplished with the finger or with the Kocher dissector (Fig. 535) in a cleavage line between the tumor and thyroid tissue.

Step 3. The vessels are ligated as encountered.

Step 4. If a cyst is inadvertently opened during enucleation, grasp the edges of its sac with artery forceps and dissect it out thoroughly.

Step 5. Obliterate the spaces resulting from enucleated masses with interrupted catgut sutures.

Be sure of hemostasis. A hematoma in an incompletely obliterated space may give rise to compression of the trachea and become a source of danger. Should the bleeding become threatening during the enucleation, or by reason of existing adhesions, the enucleation become difficult, proceed at once to resection of the respective lobe.

If, instead of a finger, a cutting instrument is used to remove the intraglandular tumor, intraglandular or intracapsular excision is spoken of.

Resection-Enucleation

If the adenoma is large, or there are multiple adenomas, resection-enucleation is better than simple enucleation. Very large adenomas which occupy the greater part of one lobe are best treated by hemithyroidectomy.

Resection-enucleation is performed as follows:

Step 1. Expose the diseased thyroid.

Step 2. The adenoma to be removed together with about one-quarter to one-half inch of gland tissue surrounding it is outlined with artery forceps and removed (Fig. 536).

Step 3. Fold the remaining thyroid tissue on itself as shown in Fig. 537 and suture it as depicted. Insure hemostasis. Drain for a day or two if deemed necessary.

Resection

This may be either frontal (transglandular) or cuneiform (wedge resection). The former is shown in Figs. 533–539. It may be performed on one or both lobes of the thyroid. The raw surfaces may be anchored to the strap muscles.

Cuneiform resection (wedge resection) [illegible]

Step 1. Ligate the blood vessels at their proper site.

Step 2. Dislocate the goiter. Ligate the thyroidea ima.

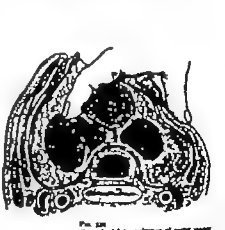


Fig. 534.

Fig. 535.

Fig. 534. Intraglandular enucleation of cystic goiter.
Fig. 535. "Kocher" dissector for use in goiter and liver work.

Step 3. Resect a wedge-shaped piece of thyroid from the respective lobe or lobes and the isthmus, if indicated. Wedge-shaped portions are removed not unlike slicing a segment out of a watermelon (Figs. 540–541). The "danger zone" must, of course, be scrupulously avoided.

Fig. 536.

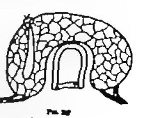


Fig. 537.

Fig. 536. Unilateral resection-enucleation.
Fig. 537. Thyroid tissue folded on itself and sutured.

FIG. [illegible] Transthoracic (lateral) resection: outline of line of removal. (After Crile.)

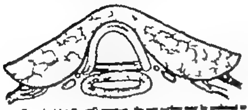


FIG. [illegible] Transthoracic (frontal) resection: the cut surface may be sutured to the [illegible] muscles.

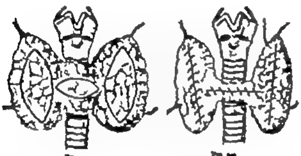


FIG. [illegible] FIG. [illegible]
FIGS. [illegible] Cuneiform resection of the thyroid. Lines of excision and of subsequent sutures. (After Crile.)

Step 4. Remove the remaining portions of the gland with interrupted catgut sutures (Fig. [illegible]).

Step 5. Insure absolute hemostasis. Reunite the superimposed structures in place.

Intrathoracic (Substernal) Goiter

Thorough anatomic knowledge and considerable technical experience are essential in attacking substernal goiter (Fig. [illegible]).

Step [illegible]. Incision and exposure as before.

FIG. [illegible] Displacement of the trachea as result of substernal goiter.

Step 2. Divide the muscles freely, particularly on the side where the intrathoracic goiter is located as "in cases of extreme gravity," says Jeff, "there can be no serious objection to division of part or the whole of the sternomastoid muscle."

Step 3. Free the cervical portion of the goiter as thoroughly as possible.

Step 4. Ligate divided vessels as you go along. Perfect hemostasis is of utmost importance.

Step 5. Separate the substernal portion of the goiter and deliver it using the cervical portion of the thyroid as [illegible] tractor. The critical time of the operation is when the thyroid passes the upper opening of the thorax. Alarming hemorrhage and dyspnea may now occur. The former may be due to injury of

one or other of the large veins (internal jugular, innominate, subclavian); the latter the result of flattening of the trachea from compression, at the moment of delivery.

Step 6. In such case replace the thyroid and allow the patient to breathe again. Do this [illegible] number of times until the goiter is successfully delivered.

Sometimes when the usual methods of delivery of the thyroid fail, recourse to resection of the manubrium sterni as advised by T. P. Dunhill (1910) may be the only avenue of approach. This, of course, is to be looked upon as [illegible] last resort and [illegible] performed as follows.

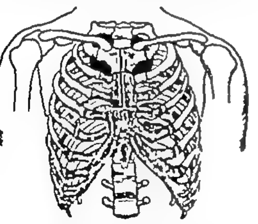


FIG. [illegible] Dunhill [illegible] method [illegible] dividing sternum to permit removal of impacted intrathoracic and substernal goiters.

Step 7. The sternum [illegible] divided in the median line (Fig. [illegible]) down to or even beyond the junction of the manubrium with the gladiolus.

Step 8. A transverse section joins the longitudinal then creating [illegible] trap door.

Step 9. Reflect part of the clavicle and the required number of costal cartilages.

Step 10. Control bleeding in the cut surface of the sternum with Horsley [illegible] wax or muscle fragments.

Step [illegible]. After removal of the thyroid the divided sternum and ribs are reunited with catgut sutures.

Step [illegible]. The operation is completed in the usual manner.

Comment. Polycystic intrathoracic goiter may be handled as illustrated in Figs. [illegible].

Operation for Malignancies of the Thyroid

The operation may be performed uni- or bilaterally.

Step 1. Make [illegible] collar incision [illegible] little higher than usual. After dividing the platysma, direct the cutting instrument toward the sternomastoid freeing its insertion over the sternum or resecting [illegible] if [illegible] is attached to the goiter.

Step 2. Divide the prethyroid muscles above and below leaving them in contact with the goiter.

Step 3. Doubly ligate the superior thyroid vessels at the upper pole and divide them between ligatures.

Step 4. Raise the growth up, ascertain the location of the inferior thyroid artery where the parathyroids and recurrent nerve is hopelessly fused with the growth.

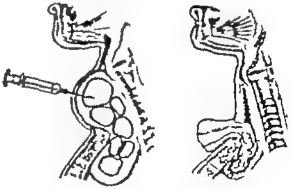


FIG. [illegible] FIG. [illegible]
FIG. [illegible] Evacuation of cysts in intrathoracic goiter.
FIG. [illegible] Tamponing of cavity following evacuation of polycystic intrathoracic goiter.

Step 5. If the internal jugular vein is attached to the growth, resect it after ligating it [illegible] thus, to preclude air embolism. If in patients under forty years of age the carotid [illegible] adherent to the growth, resect it; in older patients detach carefully.

Step 6. Elevate the lower pole of the gland, doubly ligate the inferior thyroid vessels and divide them between the ligatures. Free the goiter toward the middle, separate it from the trachea and resect [illegible]. Ligate the antero-internal branch of the superior thyroid artery before the isthmus is dissected.

Comment. Where the tumor involves both lobes, the procedure requires careful study as to whether partial or complete removal of the thyroid should be done. In some instances the superior thyroid artery cannot

reached at first; this necessitates approaching the tumor either through the isthmus or by detaching first the lower pole. The growth appears much more mobile before the operation than during it. A tumor fixed in the upper aperture of the thorax should not be interfered with. If function is caused by neoplastic infiltration, the surgeon should hesitate before undertaking an operation. In some types of thyroid tumor where the growth is enclosed in the upper opening of the thorax chances of a successful operation may be very good, provided the tumor is not fixed.

It is sometimes difficult to distinguish between a malignant goiter and thyroiditis.

Stenosis of the trachea is treated in the same way as in non-malignant goiter; however, tracheotomy is performed more often for malignant goiter than for the innocent variety.

The after treatment in this type of case consists generally of radiation, arsenic and morphin in case of recurrence.

Injections of Boiling Water

In this procedure (Wyeth's operation) the blood and albuminoids of the tissues are coagulated by injections of hot water kept at the boiling point by using a Bunsen burner; the injections are made with a needle and syringe. The temperature of the water should range from 190° to 212° F.

Step 1. Prepare the skin as usual. Anesthetize the patient. Determine beforehand the temperature of the water to be injected into the growth as well as the amount and speed with which it is to be injected.

Step 2. When treating arterial and venous angiomas insert the needle deeply into the growth, injecting 30 to 60 minims of water at one location; withdraw the needle from ½ to 1 inch and repeat the injection. Continue this procedure until the entire tumor is made firm. Exercise care in using the needle so that the surrounding parts do not slough. Do not inject more than two ounces of water at one sitting.

Step 3. Dress and keep the parts quiet. If necessary repeat the injection after 7 or 10 days.

Comment. Based on his thorough researches and careful surgery De Quervain concludes his observations as follows:

The best immediate and lasting results are obtained in malignancies of the thyroid by early radical operation (calculated to protect the air passages), supplemented by radium.

Cases best yielding to treatment as shown by all statistics are those of the proliferating type of struma of Langhans (proliferating adenoma), papilloma and hemangio-endothelioma. The worst results are obtained in cases of sarcoma.

Irradiations supplementing incompletely operated cases prolong life and require further development of technic with reference to higher dosage.

Better results are obtained when patients are referred to the surgeon early in the disease at a time when there is a suspicion of malignancy. Some improvement may result from radiation methods.

[illegible]

Removal of benign goiters and efforts directed toward the systematic eradication of endemic goiters constitute prophylactic measures.

Electrosurgical Thyroidectomy

Advantages

1. The radio knife is time-saving.
2. Hemostasis is better; fewer forceps are used.
3. In bad risk cases the reduction in time and the facilitating of the operation are contributing factors in lowering mortality.
4. More thyroid tissue can be removed with less danger to the recurrent laryngeal nerves and the parathyroid glands than with the scalpel.
5. Less catgut is used, resulting in improved wound healing.
6. The radio knife is superior to either the scalpel or the cautery in the treatment of malignancy of the thyroid.
7. It is of particular value in resecting the hyperplastic or exophthalmic type of goiter.

Disadvantages

1. The radio knife is not satisfactory for skin incision.
2. Occasional skin burns have resulted from coagulation too near the surface of the skin.
3. All important vessels must be ligated.
4. There is a tendency to postoperative hemorrhage.

Full cooperation of the nursing staff is necessary when the surgeon is using the radio knife. It would facilitate matters greatly in the operating room if units are available which could be manipulated entirely by the surgeon; there is need for much improvement on the present apparatus.

The technic may be summarized as follows:

Step 1. The usual transverse incision is made either with a scalpel or a fine, purely cutting current, and the bleeders clamped and coagulated, avoiding damage to the skin margin. The scalpel gives a neater scar.

Step 2. The usual exposure is made by dissecting the skin-platysma flaps downward and upward.

Step 3. The cervical fascia is incised in the median, freed from the capsule by blunt dissection, and retracted laterally along with the sternohyoid muscle.

Step 4. The gland is gently mobilized with a finger and clamps are placed on the superior and inferior thyroid arteries.

Step 5. The gland is attached at its superolateral aspect with the combined coagulating and cutting current instead of with the scalpel and hemostats. The current is a valuable adjunct in cutting across the thyroid tissue, by controlling bleeding and lessening the toxic substances liberated into the blood and lymph streams.

Step 6. An occasional bleeding vessel will require clamping, but usually not more than four or five are needed on each lobe, and these, with the exception of the superior thyroid artery, are sealed by clamp coagulation. So small

[illegible]

is the amount of current necessary that these vessels are sealed with but little destruction of tissue.

Step 7. The wound is closed in the usual manner.

PROTECTION OF THE RECURRENT LARYNGEAL NERVE

The points at which the nerve may be most easily injured are (a) where it crosses the inferior thyroid artery and where it penetrates under the cricopharyngeal muscle; (b) at the upper or lower pole. De Quervain says: "No surgeon has succeeded in avoiding these perils completely. . . . The proposals made for safeguarding the nerve are diametrically opposed to one another. Pay, Hildebrand, Starlin, Kocher, and others deliberately expose the nerve. The anatomical dissection presupposes previous dislodgment of the goiter—a manipu-

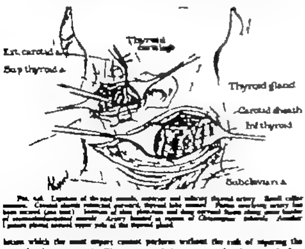


Fig. 546. [illegible]

lation which the most expert cannot perform without the risk of injuring the nerve by dragging on it. The anatomical dissection is, therefore, no absolute guarantee of immunity—although it saves the nerve from injury by forceps, or from being included in a ligature, or from an inadvertent cut with scissors. Personally we think that the remedy is worse than the disease, because the nerve is exceedingly sensitive, and practical experience supports this view. It is hardly necessary to mention the risk to the parathyroids involved in such a dissection of the retrothyroid region."

LIGATION OF THE THYROID ARTERIES

Ligation of the Superior Thyroid Artery

Step 1. Make an incision about 1 inch in length along the inner border of the sternocleidomastoid muscle below the point where the hyoid bone crosses that

muscle. Divide the platysma. Divide the deep cervical fascia vertically between the sternocleidomastoid muscle laterally and the omohyoid muscle toward the median. Palpate for pulsations and identify the vessel (Fig. 546). If there are difficulties encountered expose the superior pole of the thyroid. Ligate the artery with a blunt ligature carrier or with the author's blunt-pointed needle (Fig. 547).

Step 2. Avoid injury to the vessel. Apply a second ligature around the upper pole of the thyroid gland. An additional ligature or two at the upper pole is effective in preventing return circulation through one of the anastomosing branches, as well as cutting off the superior thyroid lymphatics and sympathetic nerve fibers.

Step 3. Close the wound.

Ligation of the Inferior Thyroid Artery

This vessel is usually ligated between the carotid sheath and the sympathetic trunk externally and the thyroid gland and the recurrent laryngeal nerve medially.

Step 1. Make a small collar incision dividing the skin, fascia and platysma. Retract the sternocleidomastoid outward.

Step 2. Incise vertically the fascia covering the sternohyoid muscle. Expose the carotid sheath. Ligate and divide any veins crossing the field. Displace the carotid artery laterally and the thyroid medially.

Fig. 547. [illegible]

Step 3. Locate the carotid tubercle (Chassaignac) on the transverse process of the sixth cervical vertebra. The inferior thyroid artery can be palpated immediately below this and to the inner side of the thyroid. Free the artery. Ligate it doubly. Occasionally anomalies are encountered (direction, number of arteries).

Step 4. Close the wound.

Comment. Should the condition of the patient become alarming during thyroid operations do not continue to operate. Leave hemostats on the vessels, pack the wound with gauze, apply a retentive dressing to the neck and return the patient to bed promptly. To persist in operating on a patient who is apparently succumbing on the table is foolhardiness. The operation may be completed, if deemed advisable, a few days later. Many a calamity may be averted by adopting this rule.

Ligation of vessels first, prevents entrance of gland secretions into the general circulation. Particularly is this of value in dealing with carcinoma of the thyroid. Another reason for such ligating is that as the operation proceeds the weight of a multitude of hemostats tugs at the tissues and thus often embarrasses respiration.

In exposing the large veins think of the possibility of air embolism. To avoid this divide the veins promptly after first doubly ligating them.

Practice ligation of the external carotid on the cadaver; it will fortify your confidence in doing thyroid surgery.

Avoid injuring the trachea during the separation of the thyroid from it. If the trachea is opened inadvertently repair it at once. A thin layer of thyroid tissue left on the trachea secures against [illegible] opening. A collapsed trachea must be combated promptly with tracheotomy.

Fig. 248. Postoperative [illegible] after removal of thyroid. [illegible] (Courtesy of Prof. [illegible])

If hoarseness develops on the day following thyroidectomy do not conclude that there is an injury to the recurrent laryngeal nerve. Postoperative edema is usually responsible for hoarseness. With the recession of the edema, the patient's voice will return.

It is better not to remove the isthmus completely, unless it causes definite symptoms of compression of the trachea. Have a competent laryngologist ascertain the condition of the vocal cords prior to thyroidectomy. This is good insurance to your reputation and the patient's welfare. Unilateral or bilateral operation? The consensus of opinion is in favor of the latter. How much thyroid should be removed? That depends upon the case. Too little is just as bad as too much (hypothyroidism, myxedema, etc., Fig. 248).

In hyperthyroidism only an amount of thyroid tissue sufficient to carry on normal function should be left behind.

It is safer to resect from the inside outward (less danger of injuring the parathyroids).

Asepsis in thyroid operations is of vital importance. Do not be alarmed by [illegible] rise in temperature following thyroidectomy. It is a common occurrence. In preparing thyrotoxic patients for thyroidectomy do not use iodine on the skin.

Complications Arising During Thyroidectomy

Dyspnea. If threatening, ascertain its cause promptly. In desperate cases tracheotomy at once.

Hemorrhage from the Superior Thyroid Artery. I have learned to leave a rather small button of superior pole tissue embraced by the ligature and place another ligature above it instead of depending upon the latter alone for security.

Commenting on this precaution De Quervain says: "Slipping of this artery should never occur if the precaution is taken of preserving a small tip of the upper pole."

Hemorrhage from the Inferior Thyroid Artery. Displace the carotid artery outward, press the lobe of the thyroid against the trachea and, simultaneously pulling it upward, locate the bleeding vessel and ligate it. Be cool! If a surgeon loses his head at this point, he will lose his patient. Pack the bleeding area for about five or ten minutes—look for the vessel again—you will find it!

Hemorrhage from the Middle Thyroid Veins. This should also be treated by compression and ligature. If the bleeding comes from the capsular veins or from those of the upper or lower pole, quick dislodgement of the respective lobe will tend to arrest the bleeding, [illegible] greater opportunity [illegible] thus offered the surgeon to search for the bleeding point and control it. If the field of operation is suddenly flooded with blood, pack promptly and properly, wait a few minutes and proceed as suggested above.

Injury to the Esophagus. While rare, I have injured the esophagus once in extirpating a large goiter which embraced the retrotracheal space for a considerable distance. Fortunately the opening was small and in the upper part of the esophagus. The patient was fed through a tube for a fortnight and the fistulous tract closed spontaneously.

Perithyroiditis Causing Adhesions. These often render the operation difficult and usually result from previously given [illegible] ray or radium treatments or antecedent operations on the thyroid. Radium and x-ray therapy obliterates the cleavage planes, and only meticulous and painstaking work will circumvent the constantly lurking dangers in these cases.

Should drainage be instituted after thyroidectomy? I always drain every toxic goiter. I never drain goiters of the non-toxic variety provided the operation has proceeded smoothly with no operative complications and one is reasonably sure of thorough hemostasis.

Tracheal Collapse and Conditions Which Simulate It. According to Cecil A. Joll[3] the term tracheal collapse is used to describe certain rare cases of acute respiratory distress occurring during or immediately after thyroidectomy. The theories advanced to explain its production are: (1) that the walls of the trachea are softened by the long-continued pressure of the goiter and, the latter being removed, there is not sufficient rigidity remaining in the tracheal wall which is therefore sucked in at each inspiratory movement and acts as an obstructive valve; (2) that although there is no actual softening of the wall of the trachea (a point emphasized by Berry) the peculiar physical characters of the cartilage-ringed walls of the trachea render it liable to collapse after removal of the tumor which surround its walls and, to some extent, hold them apart.

The difficulty Joll finds in accepting either of these explanations as invariably applicable is that he has seen [illegible] three cases in which sudden respiratory distress occurred during thyroidectomy, the whole length of the cervical trachea being under direct observation, yet no trace of collapse of its walls or of any narrowing, kink or torsion was visible. The passage of a large intratracheal tube from above temporarily overcame the respiratory difficulty, but as soon as the tube was withdrawn the dyspnea recurred. In each case tracheotomy cured the condition. It is difficult to resist the conclusion that some of the cases designated

[3] Diseases of the Thyroid. W. [illegible], London, [illegible]

tracheal collapse may be due to laryngeal spasm. It has been suggested that sudden onset of dyspnea during thyroid operations is due to bilateral injuries to the recurrent nerves, but in the cases to which Joll referred, the fact that the tracheotomy tube was removed within a week and that no subsequent trace of laryngeal paralysis could be found makes this explanation untenable.

Air Embolism in Thyroidectomy was first seen by Donald Guthrie[4] in 19[illegible] while he was an assistant at the Mayo Clinic. A. Kocher was present and assured Guthrie that no ill effects would ensue. Kocher was right. Guthrie points out that arterial air embolism which may occur in any thoracic operation, beginning with pleural puncture, is far more dangerous than the venous type, because it can lead to embolism in the brain or coronary arteries. He considers "pleural epilepsy" not a pleural effect, but a consequence of arterial embolism. The entrance of larger amounts of air into the veins leads to death. In the seventeenth century horses and cattle were killed by blowing air into their veins. The first case in the literature of fatal air embolism in man was reported in 1818. In abortions and childbirth, air embolism can lead to death, especially in placenta previa. Post-mortem examinations in these cases show foamy blood in a dilated right ventricle and in the large veins. Death occurs only if the amount of air reaches a certain minimum. Death is caused by mechanical and biologic changes. Amounts of the [illegible] of the fourth ventricle through primary cessation of breathing leads to death. Timely artificial respiration may sustain life. If after the heart has continued to function for a certain length of time, and breathing has stopped a second time, death will result. Small amounts of air compressed into the circulation cause alterations of breath and lower blood pressure. Injection of large amounts can also result in heart palpitation. Patients having hyperthyroidism, with resultant cardiac changes, are in greater peril if an air embolism occurs than are patients with other diseases. Because of the typical hissing noise followed by "bruit de moulin" of the French, a whirring, splashing sound which can be heard even at a distance of a few meters from the operating table, diagnosis is not difficult. Sometimes venous [illegible] is suspected. At times one can see [illegible] bubbles in the [illegible] vessels. Guthrie has seen, since 1932, four air emboli in goiter cases, three having secondary operations, one of which was fatal. In one case, the patient developed a postoperative paralysis on one leg without lasting invalidity. The best method of prophylaxis consists of excluding the collection of the foamy changes in the thyroid bed before ligation. In shock resort to artificial respiration supplemented by the administration of salt solution because heart [illegible] precedes paralysis of respiration. Intracardiac injection of adrenalin should be used.

Tosh reported one fatal and two mild air embolisms in 378 goiter cases during the last four years and believes they can be prevented by ligation of the veins before separating them and that air embolism may occur even after closure of the wound. It is accompanied by the cessation of breathing. The suggestion of [illegible] to draw out the foamy blood may perhaps succeed by introduction of a urethral catheter into the right ventricle through the cubital vein. A research worker demonstrated the possibility of reaching the right ventricle by a catheter introduced into the cubital vein on his own person. [illegible] believes that with accurate hemostasis, air embolism, of which he has seen a great number as a student, has become much more rare. He has observed, during a secondary [illegible]

[4] Guthrie, Donald: [illegible]

tectomy a fatal air embolism, into the coronary artery as a result of a congenital communication of both ventricles in a case of a war injury. Feustner (1934) observed an air embolism in a [illegible] year old woman, in two separate instances. At first, during the development of a retrosternal struma, a hissing noise was heard for a minute or two from which the patient recovered quickly. That same afternoon she vomited, became cyanotic and unconscious. The chest was opened, and the heart [illegible]. Artificial respiration brought relief after several minutes. Since that time, Feustner operates goiters in Trendelenburg position, which he considers the best prevention. Sternberg saw embolism twice. The vein was immediately compressed with the finger. [illegible] calls attention to the fact that most of the emboli are not fatal. He saw an exitus only once. Since the air enters in consequence of negative pressure the patient should immediately have the head lowered and the field of operation covered with moist gauze. In severe goiter cases the positive pressure apparatus should be ready because positive pressure prevents entrance of air into the veins, while Schneider emphasizes that the lowering of the head diminishes the danger but does not prevent it, especially in tracheal stenosis. Albert is of the opinion advises removal of blood from the heart by suction. Weltgartner examined the records of the Institute of Forensic Medicine since 1919 and found fifty cases of death from air embolism, more than half of these followed operations. Next in frequency to this, are abortions and puncture wounds. Several times emboli occurred in operations for injuries, four times in goiters, once in an operation for kyphosis. At postmortem the point of entrance is hard to find. One would have to fill the pericardium with salt solution, puncture the right ventricle and, if necessary, press out the blood from the pulmonary veins. Radical procedures should be used, because these cases invariably terminate fatally when less radical measures are employed.

COMPLICATIONS FOLLOWING THYROIDECTOMY

Hyperthyroidism

Comment. My experiences coincide with the subjoined conclusions of Donald Guthrie who emphasizes that:

Severe postoperative hyperthyroidism may be largely prevented by the proper preoperative treatment. It is important to consider each patient with hyperthyroidism as a separate problem and not to apply set rules or standardized methods of preparation. The cooperation of an experienced internist is invaluable in this work.

It is important to appreciate the disturbed psychic state of the patient and to understand how proper forms of suggestion will be of benefit. It is equally important to appreciate the deleterious effects of fear upon bodily physiology and to understand how easily disturbed mental states will aggravate toxic symptoms.

Anoci-association and general anesthesia are both important safeguards against the development of severe postoperative hyperthyroid reactions.

Safe thyroid surgery demands the services of a skilled anesthetist and of a well-trained goiter team.

The condition of a large group of former hyperthyroid patients, not weeks or months, but years after operation, should be the gauge

method of preparing and operating upon these patients should be judged.

No set rules can be applied to suit all cases. Every patient is a separate problem.

Crile uses, with success, dampened colloidal iodine preparation, pre- and postoperatively in hyperthyroid states and to frustrate postoperative thyrotoxic crises. Cole uses sodium iodide, intravenously, for the same purpose.

MORTALITY FOLLOWING THYROIDECTOMY

Emil Goetsch, analyzing 3,610 operations on 3,431 patients performed between 1920 and 1934, found that there were forty-two fatalities: operative mortality 1.16 per cent; patient mortality 1.24 per cent. Of these fatalities, seventeen (40 per cent) were due to postoperative crisis with secondary cardiac failure and seven (17 per cent) to primary cardiac failure unassociated with severe postoperative crisis. Five were due to pneumonia, five to embolism, and one to tetany which could have been obviated. The remaining seven fatalities were mostly accidental, of the type which do not now occur with refinement in technic.

TRANSPLANTATION OF THYROID TISSUE

Historical Notes. T. Schiff is given credit for first transplanting the thyroid in animals. Kocher receives credit for the first attempt in man in a case of cachexia strumipriva in 1883. In both cases, the functional results were only temporary. Bircher and others met with the same results when attempting transplantation of the thyroid for myxedema. Enderlen and Christiani seem to have met with the first success with this operation both as regards life and function of the transplanted thyroid tissue. Unusual results have been reported by Payr in both animal and human experiments. A large piece of thyroid tissue from a mother was transplanted into the spleen of her child, who was a victim of congenital myxedema, with very favorable results.

Serge Voronoff* describes his results followed up twenty years after grafting thyroid tissue in cases of myxedema.

Kocher met with a certain degree of success by transplanting thyroid tissue into the medulla of the tibia. He employed the following procedure:

Step 1. Form an osteoperiosteal flap in the diaphysis of the tibia. Make a pocket near the epiphyseal line where the blood supply is adequate, and in the medulla.

Step 2. Introduce into the opening a silver ball about 1 cm. in diameter and close the bone and skin flap over it.

Step 3. A few days later reopen the incision after granulation has taken place, remove the ball, irrigate the wound with normal saline solution and place the implant, which is of the same size as the ball, in the blood-lined pocket. Use normal or hyperplastic thyroid tissue from which the capsule has been dissected.

ANCILLARY THYROID OPERATIONS

The Surgical Relief of Progressive Exophthalmos

NAFFZIGER OPERATION

While, after thyroidectomy exophthalmos usually recedes, in certain individuals the exophthalmos not only does not recede but becomes progressively

* [illegible] Conquêtes [illegible], Masson et [illegible], Oct., 1939.
[illegible] Proc. Roy. Soc. [illegible], Oct., 1937.

pronounced. If not relieved, the symptoms (lacrimation, epiphora, corneal ulcerations and ophthalmitis) may become so marked that only enucleation or death relieves the patient from a pitiable existence. The disease is one of mechanical origin, being the result of a pronounced swelling of the extra-ocular muscles (often to several times their normal size). H. C. Naffziger devised an ingenious operation for the relief of this condition which is indicated in progressive exophthalmos following thyroidectomy and which has yielded him and others gratifying results.

The rationale of the operation is a decompression of the orbit and the optic foramen to afford adequate space for the increased orbital content and constricted optic nerve brought about by reflecting bilateral frontal flaps, elevating the dura *of the frontal lobe, unroofing the orbit and roofing up the upper portion of the optic* foramen, wide exposure of the orbital fascia and the ring of Zinn (Fig. 549).

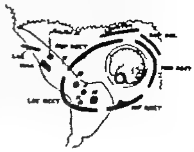


Fig. 549. Scheme to show the position of the annulus of Zinn and its relation to the structures of the apex of the orbit (after E. Wolff).

Before operation, x-ray studies are to be made to show (a) the height and extent of the frontal sinuses, (b) the projection of the frontal and ethmoid sinuses into the orbital plate and (c) views of the optic foramen showing the immediate relationship of the sphenoid sinus to it. These roentgenologic studies will point the way to avoid opening into sinuses and mastoid during the operation.

Anesthesia. Avertin 85 mgm. per kgm. of body weight and 1 per cent procaine hydrochloride for local anesthesia.

Step 1. Expose the frontal bone by a transverse incision from the temporal fossa on one side, across the frontoparietal region, immediately behind the hair line, to the temporal fossa on the other side (Fig. 550). Dissect the scalp from the pericranium and reflect it forward thus exposing the frontal bone on both sides down to the frontal sinus. Bilateral frontal flaps are fashioned, the hinge of each being the temporal muscle. A small ridge of bone is left in the midline for the purpose of stabilizing these flaps when replaced.

Step 2. *Separate the dura from the floor of the anterior fossa. Carry this stripping of the dura back to the sphenoid ridge and the base of the anterior clinoid* process. Mesially it is continued almost to the cribriform plate. The roof of the orbit is thus exposed (Fig. 551). Carefully separate the orbital fascia.

Step 3. Remove the roof of the orbit with rongeur forceps. Carry the opening in the bone forward, anteriorly, to the frontal sinus and laterally to a point where the orbital roof merges into the lateral wall of the skull and posteriorly to the sphenoidal ridge. Leave only a thin line of bone attached to the small wings which is to be found in the dural reflection. Remove the roof of the

optic foramen and its supraorbital margin (Fig. 552). X-rays of the optic foramen will show its relation to the sphenoid sinus. The orbital contents will bulge into the opening as it is enlarged.

Step 4. Open the orbital fascia. Avoid the frontal branches of the fifth nerve, working by blunt dissection. Expose the levator superioris and superior rectus muscles. Avoid the nerve supply which comes from below.

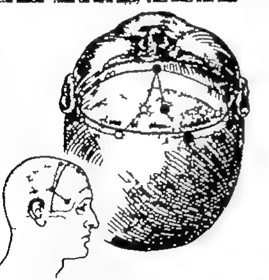


Fig. 550. Incision used. The solid black line indicates the coronal incision; the dotted lines, the two osteoplastic flaps. (Courtesy of Dr. Howard C. Naffziger.)

Step 5. Expose the internal and external recti similarly. The muscles are usually enormously enlarged (Fig. 553). In some patients, Naffziger carried the dissection down to expose the capsule of Tenon and the optic nerve as it enters the globe. Ordinarily this is unnecessary: the orbital fascia being open in all directions. The annulus of Zinn surrounding the orbital fissure and the optic foramen may be slit, usually at the outer margin of the superior rectus muscle.

Step 6. Hemostasis. Allow the dura to come down and rest directly on the orbital content. Carry out a similar procedure on the opposite side. Replace the bone flaps and suture them together across the ridge of bone in the midline. Replace and suture the scalp in position. Suture the galea and skin separately. Fill the openings in the bone with bone dust. Protect the cornea carefully.

OPERATIONS ON THE PARATHYROID GLANDS

Hyperparathyroidism* is a distinct disease-entity associated with a definite train of symptoms and a characteristic disturbance of calcium and phosphorus metabolism. It is commonly associated with a demonstrable adenoma, usually of

Fig. 551. Intracranial approach to the orbit. Part of the orbital plate removed, exposing the fascia of the orbit. (Courtesy of Dr. Howard C. Naffziger.)

gross size of one or more parathyroid bodies. Following the total or subtotal resection of the tumor the calcium and phosphorus metabolism returns to normal, usually after a more or less prolonged period of tetany.

The beneficial effects said to follow the removal of one or more normal parathyroids in certain cases of arthritis or in Paget's disease are, to say the least, viewed with skepticism.

*The removal of normal parathyroid bodies or interference with their blood

* Churchill, E. D., and Cope, O.: Surg. Gynec. and Obst., 58: 255, 1934.

[illegible] operating [illegible] definite diagnosis of hyperparathyroidism is [illegible] indicated.

[illegible] resection of [illegible] parathyroid tumor is advisable when normal glands have been removed or destroyed at [illegible] previous operation. [illegible] resection may also prove to be the operation of election in [illegible] very sick patient to lessen the

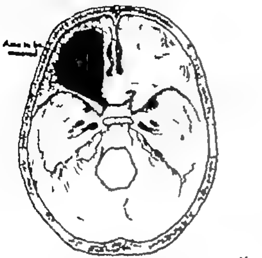


Fig. [illegible] [illegible] The base of the skull showing the area of bone removed [illegible] (Courtesy Dr. [illegible])

[illegible] of severe [illegible] It has been done in one such case. The [illegible] of the [illegible] being unknown at the present time, complete resection is the operation of choice.

[illegible] reported, in 1926, [illegible] parathyroidectomy in [illegible] of [illegible] Recklinghausen's disease. Others verified [illegible] findings.

PARATHYROIDECTOMY

Removal of [illegible] parathyroid tumor [illegible] sometimes called for in cases of generalized osteitis fibrosa. [illegible] Parathyroids are seldom palpable; therefore, [illegible] [illegible]

Step [illegible] Make [illegible] collar incision as for thyroidectomy. Divide the [illegible] muscles [illegible]

Step [illegible] Expose the [illegible] thyroid gland thoroughly. Incise the thyroid sheath over each lobe.

[illegible] and [illegible]

Step 3. After ligating and dividing the middle thyroid vein, rotate the corresponding lobe medially and complete the separation of the thyroid [illegible] from the capsule covering the posterior surface of the lobe. The [illegible] of the superior or inferior parathyroid body is now exposed. The tumor may be found on either side of the trachea or in the superior [illegible]

Fig. [illegible] [illegible] [illegible] (Courtesy Dr. [illegible])

Step 4. Remove the tumor. This is usually not difficult. [illegible] calls attention to the fact that when the parathyroid tumor cannot be found in any of these situations, it is probable that it [illegible] one or other of the inferior parathyroid glands which may lie behind the thyroid sheath. It is necessary, therefore, in such instances to [illegible] the thyroid sheath on one or both sides immediately above the level of the inferior thyroid artery and to search for the tumor alongside the esophagus, or [illegible] where it may have passed down behind the esophagus to rest upon the bodies of the upper thoracic vertebrae.

Churchill and Cope's Operation for Parathyroid Tumors Associated with Hyperparathyroidism

It [illegible] best to locate [illegible] small parathyroid adenoma in the first surgical exploration of the neck. Strict attention should be paid to hemostasis, as the staining of the tissues with blood makes [illegible] difficult to identify the parathyroid tissue. [illegible] ligate over the [illegible] vessels before [illegible] It is important that all tissues be carefully handled by sharp dissection, as [illegible] hematoma may quickly develop

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Parathyroid tumors associated with hyperparathyroidism [illegible] [illegible] Only the [illegible] [illegible] (Courtesy of Drs. Edward D. Churchill and Oliver Cope and Surgery, Gynecology and Obstetrics.)

following an injury to the parathyroid body. A parathyroid [illegible] hemorrhage [illegible] type [illegible] If this is present there [illegible] danger of postoperative tetany.

Do not cut into the thyroid gland, as the resultant hemorrhage will obscure the operative field. Use traction stitches of fine silk instead of double hooks to retract the thyroid. After hyperparathyroidism has been established proceed as follows:

Step [illegible] Try to locate the tumor by means of [illegible] Take films to outline the trachea and [illegible] the superior mediastinum. Look for [illegible] calcified capsule or displaced trachea. Use [illegible] of thick barium to outline the esophagus in both anterior and lateral views. A filling defect or displacement of the esophagus may indicate the position of the tumor.

Step 2. After anesthetizing the patient, preferably [illegible] make [illegible]

collar incision, section the pretracheal muscles and dissect the middle cervical fascia from the surface of the thyroid. Look for any [illegible] of tumor behind the thyroid.

Step 3. Identify the carotid sheaths and cut the lateral thyroid veins between ligatures. Palpate the [illegible] aspects of the thyroid and retract them [illegible] Continue the dissection downward on one side until the recurrent laryngeal nerve is identified and the region of the [illegible] of the inferior thyroid artery exposed. Repeat this on the opposite side.

Step 4. Expose the trachea and esophagus and carry dissection upward to the larynx and downward into the superior mediastinum (Figs. 534, 535). Sever the branches of the inferior thyroid artery individually as they enter the capsule of the thyroid, making sure the blood supply of any normal parathyroid body is left intact (Fig. 536).

Step 5. Insert the finger back of the sternal notch deep to the middle cervical fascia [illegible] the anterior mediastinum. Insert the finger into the posterior mediastinum behind the trachea and esophagus. At the same time introduce [illegible] finger of the other hand into the posterior mediastinum on the other side. Palpate the structures of the mediastinum between the two fingers. If [illegible] tumor [illegible] identified, deliver it into the operating field with gentle traction. Do not remove normal parathyroid bodies if no tumor is found.

If no tumor is found after complete dissection of the neck and palpation of the mediastinal structures, recheck the diagnosis during convalescence. At the conclusion of an unsuccessful operation [illegible] [illegible] small button of bone from the sternum if that has not already been done. If the diagnosis is confirmed, explore the mediastinum under direct vision by section of the sternum. Under positive pressure anesthesia make [illegible] incision downward from the sternal notch [illegible] to the right at the level of the third costal cartilage. Insert [illegible] finger into the mediastinum and direct upward behind the sternum pushing the great vessels backward to avoid injury. Split the sternum with Lebsche sternum knife and retract the two halves bringing the anterior mediastinum into view (Figs. 537, 538, 539-540).

Fig. 536. Parathyroid tumors associated with hyperparathyroidism [illegible] (Courtesy of Drs. Edward D. Churchill and Oliver Cope and Surgery, Gynecology and Obstetrics.)

In [illegible] final attempt to locate [illegible] tumor undertake blunt dissection of the neck above the larynx.

[illegible]

Churchill follows the principles of Cline for [illegible] operations on the parathyroid (Fig. [illegible]).

FIG. [illegible]. Parathyroid tumor [illegible] in hyperparathyroidism. First step in anterior [illegible] (after [illegible]) (Courtesy of Drs. Edward D. Churchill and Oliver Cope and Surgery, Gynecology and Obstetrics.)

FIG. [illegible]. Parathyroid tumor exposed by retraction of the two halves of the sternum. The [illegible] (Courtesy of Drs. Edward D. Churchill and Oliver Cope and Surgery, Gynecology and Obstetrics.)

FIG. [illegible]. Bilateral exposure of the lower borders of the [illegible] (Courtesy of Drs. Edward D. Churchill and Oliver Cope and Surgery, Gynecology and Obstetrics.)

FIG. [illegible]. Removal of [illegible] tissue [illegible] (Courtesy of Drs. Edward D. Churchill and Oliver Cope and Surgery, Gynecology and Obstetrics.)

Step [illegible]. Section the prethyroid muscles, enter the deep areas of the neck on both sides through the carotid sheaths.

Step 2. Identify and retract the great vessels and the vagus nerves laterally. Find the trunks of the cervical sympathetics overlying the deep cervical fascia. Isolate the recurrent nerves as low as possible and trace them upward toward the larynx. Identify the thoracic duct.

Step 3. Explore the [illegible] around the thyroid only after the exploration has been carried [illegible]. Normal parathyroids or their vascular pedicles may be injured here, but [illegible] tumor would likely have been identified by the first surgeon.

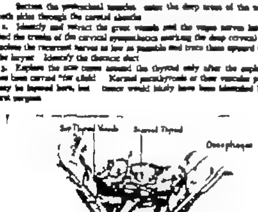


FIG. [illegible]. Parathyroid tumor [illegible] with hyperparathyroidism. [illegible] (Courtesy of Drs. Edward D. Churchill and Oliver Cope and Surgery, Gynecology and Obstetrics.)

SUBTOTAL PARATHYROIDECTOMY

This operation is indicated where damage has been done to normal glands or their blood supply. The capsule [illegible] to form [illegible] compact body and its location clearly marked. In the case of mediastinal tumors, transfer the residual tissue, with its vascular pedicle intact, to the neck. The cases operated on showed marked urinary [illegible] with subtotal resection.

In some advanced cases accompanied by extensive decalcification of the bones, subtotal resection is indicated even if the normal parathyroids are intact. Severe tetany sometimes follows the removal of [illegible] large adenoma even when limited dissection made damage to other parathyroids improbable. Death has been known to follow from uncontrollable metabolic disturbance caused by total resection of [illegible] tumor.

Comment. In speaking of the results of the operation, Churchill and Cope state: "The immediate result in the cases from which [illegible] parathyroid tumor has been removed either completely or by subtotal resection, has been correction of the disturbance in calcium and phosphorus metabolism. In fact, postoperative studies showing the return to normal constitute the final [illegible] in establishing the diagnosis and efficacy of the treatment. They are

[illegible] building on the expected cases of Paget's disease and arthritis. Following removal of the tumor in true hyperparathyroidism the serum-calcium values fall with [illegible] rapidity. Symptoms and signs of tetany may appear even with [illegible] serum calcium above the normal level when hypercalcemia has been present for [illegible] long time. The tetany is controlled by high calcium diet, administration of calcium gluconate, [illegible] and parathormone.

Improvement in many of the symptoms of hyperparathyroidism may be expected within [illegible] few days. In several instances the patient has only been made conscious of certain long standing but ill defined symptoms such as loss of energy, constipation or fatigue by their abrupt cessation following operation. These symptoms are then recognized in retrospect as manifestations of the disease. The muscle and joint pains as well as bony tenderness are promptly relieved. The replacement of calcium in the bones takes [illegible] longer time and many months may elapse before any change becomes apparent by x-ray. The bone tumors being [illegible], may be expected to disappear, but the bone cysts formed by fibrous replacement of bone substance persist.

"How far the kidney damage may be repaired is not known. In certain cases some improvement in renal function has been observed. The only fatality in the [illegible] cases here presented occurred following the removal of ureteral stone several weeks after the removal of [illegible] parathyroid adenoma.

PARATHYROID TRANSPLANTATION

In discussing Transplantation of Living Grafts of Thyroid and Parathyroid Glands Harvey B. Stone[1] concludes:

"In dogs, certain endocrine tissues may be transplanted successfully from one individual to another. Factors of success in such transplants include the choice of proper site for the graft, proper size and form of the graft, and biochemical adaptation of the graft to the host. The cells and grow are proper sites. The grafts should be very fragments or tissue cultures. The grafts should be grown in cultures in medium containing the blood fluids of the host to adapt it before implantation.

In human beings, ten cases have been subjected to grafting treatments, using the methods developed by experiments on dogs. Five of these were grafts of thyroid tissue and five were grafts of parathyroid tissue. Of these ten cases, only two are of sufficiently long standing to permit an opinion as to the success of the experiment—both of them being parathyroid tetany cases. In both of them we believe we are justified in assuming that the grafts were successful."

Tissues chosen to receive the implant should have [illegible] generous blood and lymph supply: the subcutaneous tissues, preperitoneal tissues, omentum, spleen and bone marrow have all been recommended.

Step [illegible]. Select [illegible] parathyroid in [illegible] location free from blood in [illegible] patient who is undergoing [illegible] operation but is otherwise healthy. The surgeon should make sure that the patient will suffer no ill effects from parting with [illegible] parathyroid. The removed parathyroid is placed in Locke's solution and kept at body temperature until implantation takes place. Implantation immediately upon removal is to be preferred.

Step [illegible]. Anesthetize the patient and form [illegible] preperitoneal pocket free from blood

[1] Annals of Surgery, October, [illegible].

under the rectus abdominus muscle. Local anesthesia is best avoided as it may interfere with the transplant.

Step 3. Split the parathyroid without taking it out of the solution or suture it so that there are two raw surfaces; the procedure varies according to the size of the organ. Place the implant in the pocket made for it with as little han-

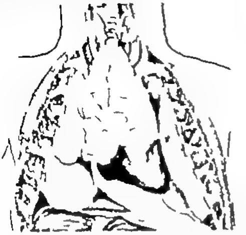


Fig. [illegible]. Thymus of newborn babe (natural size). [illegible]

dling and exposure to the air as possible. Check bleeding and close the incision without drainage.

Frugoni and Banis reported a case (Il Policlinico, Sezione Pratica, [illegible]) in which a graft from a human gland persisted for eight years in a patient twenty-one years of age. The operation was performed by Borgo Varesotti.

OPERATIONS ON THE THYMUS

THYMECTOMY

Anatomic Considerations. To all appearances, the thymus seems to be associated with the development of the unborn child and infant (Fig. [illegible]). It increases in size in proportion to the size of the body until the child is about two years old. After that it grows larger in some parts, diminishes in other parts, adipose formations appear followed by degeneration of the gland. Before degeneration takes place, it is firm and pink in color; later it is similar in appearance to adipose and areolar tissue and is very easily torn.

The thymus is enveloped in a capsule of fibrous tissue which branches project

among the lobules. It is found behind the upper part of the sternum and when reaches its greatest size it projects for a short distance into the neck and extends down to about the fourth costal cartilage and in unusual cases as far as the diaphragm. The thickest part of the thymus rests on the pericardium, extending from here into two flat lobes which become thinner and more divergent as they descend. The left lobe overlaps the right and is separated by a layer of fibers. The left lobe is generally the larger of the two. [illegible] between them.

The thymus is in touch with parts of the aortic arch while the innominate veins and superior vena cava form a furrow on its posterior surface. It extends into the

Fig. [illegible]. Thymectomy. Transverse incision over manubrium. The superficial fascia of the neck [illegible]. The [illegible] are [illegible].

space between the pericardium and pleura on either side. Before atrophy takes place, the thymus resembles [illegible]. The suspensory ligaments connect the thymus capsule to the thyroid. The internal mammary vessels follow their course in front of it. Authorities differ widely concerning the weight of this body at birth [illegible] being given as average figures. It [illegible] at puberty after which it becomes thinner and other [illegible] being replaced by fat and areolar tissue but rarely disappears completely although after [illegible] years of age [illegible] and easily [illegible]. The internal mammary, thyroid and pericardial arteries furnish the blood supply for the thymus through capillaries at the junction of the medulla and cortex. The veins join together forming larger trunks, the left innominate being the most important. There are many large lymphatics which empty into the nodes behind the sternum and form a plexus around the lobes.

Anesthesia. Crotti admonishes that "in children, especially in the newborn, the dyspnea may be so intense that anesthesia, no matter what form, may only increase the dyspnea; consequently in such conditions the operation may have to be performed under local anesthesia or with no anesthesia at all as in

the newborn for instance. [illegible] In small children chloroform seems to be preferable to ether."

The patient's position is the same as in classical thyroidectomy.

Step 1. Make a transverse incision above the manubrium of the sternum. Retract the lips of the wound. Divide the cervical fascia in the median line (Fig. [illegible]).

Step 2. Separate the prethyroid muscles in the median. Retract them laterally. Look for the upper lobes of the thymus, which will ascend and descend during the respiratory excursions.

Step 3. Deliver the thymus into the wound by gentle traction on its upper pole. Attend to hemostasis during delivery (Fig. [illegible]).

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Thymectomy. The capsule of the thymus is grasped with a pair of forceps, pulled upward, forward, and incised.

Fig. [illegible]. Thymectomy. The thymus has been removed. The capsule of the thymus is sutured to the fascia and sternum.

Step 4. Crotti counsels extracapsular resection of the thymus, stating that usually the thymus is easily loosened from the surrounding structures. Whenever however there is some perithymusitis and consequently there is some difficulty in getting the thymus up, it is better then to perform an intracapsular thymectomy. Under such circumstances the capsule of the thymus is opened permitting the parenchyma of the gland to protrude during the expiratory excursions [illegible]. Shell out the gland digitally with care (Fig. [illegible]).

Step 5. Ligate the base of the thymus snugly. Make it sufficiently above the ligated base to avoid slipping of the ligature. In an emergency (hemorrhage) tight packing should be resorted to.

Step 6. Attend to hemostasis. Reunite the prethyroid muscles. Suture the platysma. Close the skin. Drain.

TUMORS OF THE THYMUS

This surgery is of a very different type.

Lilienthal says, "Greater progress would be made if it were possible to perform more exploratory operations for suspected tumors in this region before such proportions have been reached that a complicated operation with its added dangers has become necessary. Also, there would be less embarrassment from the greatly dilated veins which are present later on in the disease. The method of approach

when the tumor does not extend too far beyond the borders of the sternum is by Milton's operation (Chap. [illegible]) or one of its modifications. The thymic tumors are small in size and should not add greatly to the dangers, but means for differential pressure must be ready with an anesthetist skilled in their use in case one or both pleurae are wounded. Where it is obvious that we are dealing with an inoperable condition some relief may be secured by the decompression afforded by a longitudinal division of the sternum and its posterior periosteum. Large mediastinal tumors spreading laterally need not of necessity cause distress by pressure upon the trachea as do those confined to the mediastinum itself.

CHAPTER 18

PRINCIPLES OF PLASTIC SURGERY AND SKIN GRAFTING

Historical Notes. The Hindus practiced skin grafting and plastic surgery two thousand years ago. A customary form of punishment was cutting off the nose. Men belonging to the tile maker caste consequently became skilled in grafting on noses formed from the skin of the gluteal region. It is doubtful if similar operations could be done as successfully today, since there is no record of the exact technic employed by these operators. It was believed at that time that the graft atrophied or grew healthy in accordance with the state of health of the original donor.

There is very little recorded concerning the progress of this art during the middle ages. Toward the end of the eighteenth century Indian methods of grafting were introduced into Europe. At about this time Tagliacozzi, a famous Bologna surgeon, is given credit for some very fine work in rhinoplasty.

RECONSTRUCTIVE AND AESTHETIC PLASTIC SURGERY

Plastic surgery designates that branch of general surgery which deals particularly with repair and reconstruction in connection with defects and malformations, whether these may be congenital or acquired. It includes not only the improvement of appearance but, so far as possible, the restoration of function. Plastic reconstructive work may, and generally does, consist in building up local defects with tissue obtained from the immediate vicinity or even from a considerable distance from the defect, but it also often includes removal of the localized redundant tissues and remodeling what is left so as to produce a normal or approximately normal appearance. This type of plastic reconstructive work and all operations which are undertaken principally for the removal of unsightly disfigurements may in a general sense be described as aesthetic plastic surgery, but many of these operations have not merely an aesthetic but also an economic and therapeutic value. (See Surgery of the Breast, etc.) Aesthetic plastic work, at present, is to a great extent confined to the facial and other exposed regions, but in the case of women, it may include the breasts, abdomen and other parts which have become unsightly and burdensome. General plastic work not only includes the aesthetic type but also work on bones, joints, tendons, etc. so as to eliminate pain and restore function. This type of plastic work may be called for in any region of the body following the healing of traumatisms or to remedy such congenital defects as webbed fingers, deformed feet or the like. The plastic work may require manipulation of bone, muscle, fascia, fat and skin, either in situ or transplanted from a distance. By the term "take" we mean that the entire graft has healed in its new position. By "partial take" we mean that the tissue transplanted has only partially healed.

The surgeon who undertakes plastic work should, therefore, be thoroughly familiar with the behavior of such tissues under all conditions and very particularly with their mode of healing when transplanted. He should also be conversant

with the possibilities of tissue-transplantation and the use of free and pedicled flaps and grafts. By a "flap" is meant a segment of tissue detached from its natural bed for the greater part of its extent. The part by which it is left attached to its original surroundings (pedicle) carries blood vessels, thus supplying nourishment to the detached part of the flap. The detached part may be applied to a raw granulating surface and, if this latter is well vascularized, the flap will, as a general rule, soon become itself vascularized and when this occurs, the flap may be entirely detached from its nutrient base. A "graft" may be entirely detached from its surroundings and connections and transferred to the place for which it is intended, where in due time it may become vascularized and live incorporated in its new surroundings. Bone, cartilage, skin and perhaps other tissues may be freely grafted or transplanted and under certain conditions will permanently live in the new site; other tissues and even parts of internal organs can be transplanted, become vascularized and live for a greater or lesser time in their new environment (Alexis Carrel). The free ends of the same or different tendons may be sutured together and will in time become integrate.

It will be seen that the operations of plastic surgery are manifold and the knowledge of technic demanded from the plastic surgeon is immense if he covers all the fields embraced in this type of surgical work. Many procedures, such for instance as arthroplasty, are undertaken by the general surgeon as a part of his general work.

TWO MAIN PRINCIPLES OF PLASTIC REPAIR

1. The proper preparation or vivification of the surface or site of the plastic work.

2. Complete absence of tension when and after flaps or grafts are applied. These principles are perhaps more applicable to superficial than to deep plastic work and in this chapter we will confine our attention principally to superficial plastic work.

The first of the main principles just referred to must of necessity presuppose certain general conditions in regard to the patient; he should be free from all active diseases such as syphilis, tuberculosis or suppurative disease of any kind; he should not be aged or feeble and his general health should be good. In the case where a plastic operation is being performed to remedy defects due to traumatism, such as a burn, the healing process should be complete and the patient in good general condition. All scar tissues must be completely removed from the surface and all bleeding arrested before a flap or graft is applied to it.

METHODS OF PLASTIC REPAIR

When a superficial defect has to be repaired by a plastic operation which includes skin covering, the following methods may be employed: (a) Skin grafting; (b) The French Method (sliding the edges together and suturing). This method was originally devised by Celsus. In such cases of tension, the skin may be mobilized to a great extent by undercutting. In this manner large areas of skin may be shifted without impairing the viability of the transplant. (c) The Italian Method, which consists of using pedunculated flaps from tissues in the immediate neighborhood with more or less torsion of the pedicle. (d) The Italian or Tagliacotian Method: the use of pedunculated flaps from distant parts, as

for instance when a nasal defect is to be repaired by a flap of tissue from the arm. While the method is inconvenient for the patient, requiring immobilization of the arm for a long period, the procedure assures nourishment of the flap. (e) The Gillies Tubed-Pedicle Flap. In treating soldiers who had been wounded during the World War it often happened that no local flaps were available to fill in defects where something more than epithelial covering was needed and it became necessary to obtain flaps from a distance. Thus Gillies' tubed pedicle flap was

Fig. 5[illegible]. Plastic surgery. Making a [illegible] and [illegible] of the hand through a [illegible] flap taken from the abdominal wall.

developed. It is an excellent way to transfer whole skin together with the necessary amount of subcutaneous tissue from one part of the body to another. The wall of the abdomen usually furnishes this flap. The accompanying illustrations describe better than words the method of procedure (Fig. 5[illegible]). The flap may be used for repairing various defects.

Flaps

Flaps for plastic work are usually thick and include the subcutaneous tissue which contains the blood vessels supplying the skin, so that vitality is not impaired. The deep fascia is not, as a rule, included in the flap. In some cases, as in certain kinds of rhinoplasties, a flap may be cut containing bone and periosteum.

It is not within the province of this chapter to describe the many types of defects for which flaps may be employed nor the manner in which they may be utilized. Each type of defect will have to be handled according to its own particular circumstances and the judgment of the surgeon. There are, however, certain principles which apply to flaps of all kinds. When a flap is obtained from the vicinity of a defect it may be glided into its new position and fixed there by sutures. In the case, for instance, of an external wound left following amputation of the breast, when the edges cannot be approximated, flaps may be obtained from the axillary or shoulder region and slid into the defect (sliding flaps). There is some danger of necrosis when such a flap is transplanted.

Davis and Trout have ably illustrated and described the various types of flaps used in modern plastic work. A study of the illustrations and legends (Figs. [illegible] and [illegible]) will do much to elucidate the factors under consideration than any amount of text.

According to circumstances, flaps in plastic work may be used in different ways. There is the reversed flap in which the cuticle is directed inward, the outer surface being later covered by a skin graft. This may be indicated in repairing defects in the cheek or other regions having a mucous lining. In the superimposed flap the first reversed flap is itself covered by a second flap with its cuticle outward, or the first reversed flap may be folded on itself. A granulating flap is a double pedicled one in which the superficial tissues are dissected up but the extremities left intact. The isolated part forms a kind of bridge the undersurface of which is prevented from uniting to its surroundings by some protective material and then allowed to granulate for from ten to fourteen days. Experience has shown that the vitality of such a flap in its new position is

Fig. 5[illegible]. Illustrating the Halsted [illegible] suture. [illegible] Dr. W. S. Halsted [illegible]

were secured after the pedicles have been divided if the deeper parts are grant[illegible] [illegible]. Moreover such flap can be cut much longer in proportion to its width than other flaps without fear of sloughing; the length may be three times the breadth.

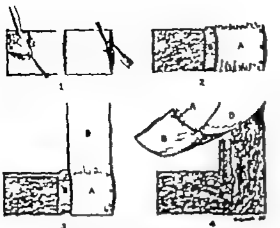


Fig. 348.—Illustrating method of [illegible] flap by the use of [illegible] [illegible] [illegible]. (Davis and Traut in Lewis' Practice of Surgery.)

When a flap has been used for filling up a defect or other plastic procedure it will, of course, be necessary to fit and trim it so as to leave no projections over the contiguous tissues. When an exact fit has been accomplished, it should be sutured in place. The suturing of a plastic flap is a most important procedure. Silkworm gut or fine horse hair commonly used, every effort being

made to obtain good apposition between the edges of the flap and those of the prepared bed. Catgut may be used for buried sutures if they are necessary, or for the union of mucous surfaces. Fine horse hair is employed where the situation calls for the avoidance of stitch marks.

The management of tension is a delicate matter. There should be enough but not too much; the condition of the sutured edges should be constantly inspected and any dragging stitches removed. Usually after suturing there is always some swelling of the flap and of the tissues surrounding it; such these

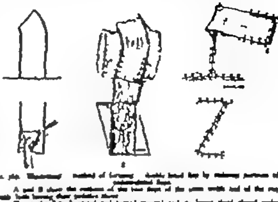


Fig. 349.—Illustrating method of forming a double lined flap by [illegible] [illegible] of two [illegible] flaps. (Davis and Traut in Lewis' Practice of Surgery.)

lines, that may at first seem to appear slack, will soon tighten up. Too much tension may occur with the appearance of a zone of inflammation which, if not corrected in time, may be followed by sloughing.

Different modes have been devised for the closure or filling of deformity gaps of varying shapes. Triangular-shaped gaps, if small, may have the edges brought into apposition by simple undermining of the subcutaneous tissues and suturing the skin edges together. When such gaps are of larger size an incision is made continuous with one side of the triangle; the subcutaneous tissues beneath the edge of this incision and of the side of the triangle next to it are undermined in its direction; the loosened-up skin may then be sutured over the defect. If necessary, the original incision may be continued on both sides continuous with one side of the triangular gap and the same procedure followed on each side. Quad-

rilateral and elliptical gaps may be dealt with in a similar manner by undermining the subcutaneous tissues around them.

The most satisfactory method of suturing skin edges in plastic work is the single curved or vertical mattress suture to prevent overlapping of the edges. This suture may also be used for coapting mucous membranes. A continuous mattress suture may also be employed.

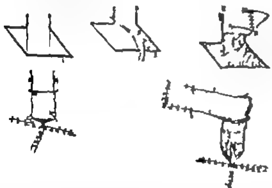


Fig. 350.—Illustrating method of [illegible] [illegible] flap by [illegible] [illegible] [illegible]. (Davis and Traut in Lewis' Practice of Surgery.)

In the French method of cut out flaps for plastic work the skin edges, both of the flap and its bed, are undermined and the subcutaneous tissue pads removed. This enables the surgeon to bring the skin edges into better apposition and to avoid undue tension. Another method is to incise the edge of the flap on the slant so as to produce a bevel edge. This appears to give a larger area of epithelial surface for union, while the thin edge having the character of an epithelial graft is apt to fuse with the opposing skin and to produce a rapidly healing scar. If this method be employed it seems best to use a non-subcutaneous mattress suture with few interrupted edge-to-edge sutures. Tension sutures may be inserted externally along the united edges, care being taken to prevent cutting by tying them over strips of rubber.

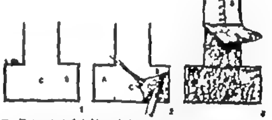


Fig. 351.—Illustrating method of lining the lower portion of a [illegible] flap by folding [illegible] [illegible]. (Davis and Traut in Lewis' Practice of Surgery.)

Fig. 352.—Illustrating method of lining a flap by folding its end. (Davis and Traut in Lewis' Practice of Surgery.)

APPOSITION OF FLAPS

Some surgeons doing plastic work have found it advantageous to approximate divided edges without suturing them together. This is accomplished in different ways. Strips of muslin to which hooks have been sewn may be glued

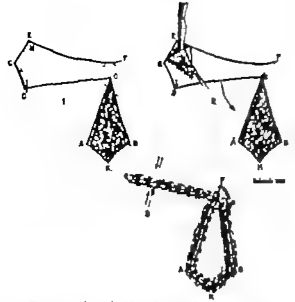


Fig. [illegible]. Illustrating the closure of a defect with a pedunculated flap having a very narrow pedicle.

The defect with the outline of the proposed flap. It will be noted that the pedicle very narrow and the flap long. A pedicle as narrow as this must carry an artery to nourish the flap, otherwise necrosis would surely take place, at least in part, even though delayed transfer were resorted to.

2. The flap being raised. Note the dissecting of the trunk of the pedicle. Before suturing the flap the [illegible] adjacent to point C were undermined.

The flap sutured into the defect. The area from which it was raised was closed by sutures. Note the position of the points F and C as compared with that in 1. (Davis and Traut in Lewis' Practice of Surgery.)

to the shaved and cleaned skin-surfaces and the edges of the gap approximated by lacing up the hooks. [illegible]'s glue is one of the many similar preparations used for keeping the strips in place. It is composed of resin, [illegible] Gm.; alcohol ([illegible]) [illegible] cc.; Venetian turpentine [illegible] cc.; [illegible] [illegible] cc. There are various other non-suture methods such as the use of metal clips (Michel).

One thing to be borne in mind in connection with plastic work is that infinite patience both on the part of the operator and patient is called for. There must be no hurry and numerous operations may be required before a satisfactory result is obtained.

After-Care

Where there are no infective complications, the part should be immobilized and soft, non-irritating dressings applied with even pressure. If the dressings are tight, the blood supply may be interfered with and a slough result.

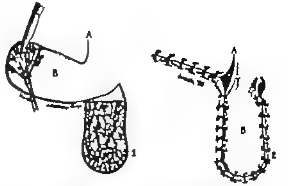


Fig. [illegible]. Illustrating the closure of a defect with a single pedunculated flap [illegible] [illegible] with twisting of the pedicle by the [illegible] method.

The defect with the proposed flap outlined. Note the triangle of skin between the pedicle of the flap and the upper end of the defect. In [illegible] [illegible] it is advisable to [illegible] this area in order to make a better closure.

The flap sutured down with a partial twist of the pedicle and sutured into position. Note the closure of the area from which the flap was raised. When closure cannot be made advisable to skin graft the defect. The [illegible] produced by the twist of the pedicle can be removed later should it be objectionable. (Davis and Traut in Lewis' Practice of Surgery.)

Massage, or passive movement, is of great value both before and after operation. Before operation, scars may be made movable and the circulation in the region improved. Following operation, massage helps in restoring lost function; areas that have been grafted may be loosened up a bit and the color and circulation in the grafts improved. But massage should not be commenced until at least three weeks following operation.

In speaking of the Treatment of Superficial Granulating Wounds, John E. Cannaday[1] points out that Sir Walter Scott tells of the old belief among the Highland clansmen that a wound heals better if the first dressing is not changed for a long time and that the dried blood in the dressing was beneficial and protected healing. Chutro, of Buenos Aires, in dealing with war wounded in Paris

[1] Am. Jour. Surg. Vol. XXV, No. [illegible], [illegible].

during the World War, strongly stressed the great value of infrequent dressings and non-interference with wounds during the process of healing. He did not dis-

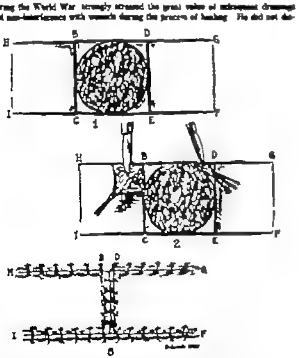


Fig. [illegible]. Illustrating a method of closing a circular shaped defect by the removal of four triangles of skin, thus changing the defect from a circle into a square. Lateral square flaps are undercut and advanced, and the closure is in the shape of an H. [illegible]

Shows the circular defect with the triangles outlined and the incisions made to form the lateral flaps.

[illegible] the removal of the triangles convert[illegible] the circle into a square. Also the raising of the lateral flaps.

The lateral flaps have been advanced to meet each other and have been sutured. [illegible] [illegible] the closure of all of these circular defects on [illegible] method of [illegible] [illegible] [illegible] [illegible] with [illegible] and [illegible] [illegible] [illegible] [illegible] triangle and square. In other words, by used combinations of [illegible] [illegible] [illegible]. In plastic surgery [illegible] must be [illegible] made in order to meet [illegible] which [illegible] arise. For this reason, [illegible] [illegible] for the operator to have mastered the methods of closing defects of various shapes. (Davis and Traut in Lewis' Practice of Surgery.)

turb the dressing for from two to three weeks or longer. Orr popularized a somewhat similar method. He packs the wound with vaseline gauze, applies a plaster

cast over this and not infrequently does not disturb the dressing for a full month, the odor often being the indication for a change of dressing.

Wounds of the face that have not been dressed, apparently heal in a much more kindly and prompt manner than those that are covered with dressings. As far as the wound's healing is concerned, dressings are, as a rule, of no value

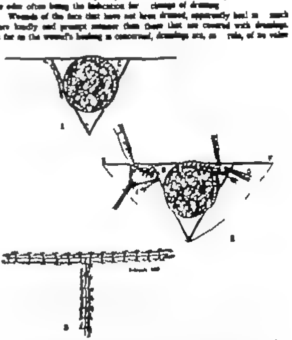


Fig. [illegible]. Illustrating a method of closing a circular defect by the removal of three triangles of skin, thus changing the defect from a circle to a triangle. Lateral triangular flaps are formed and the closure is the shape of a [illegible]. ([illegible].)

Shows the defect and the incisions outlining the three triangles, C, [illegible] which are all to be removed. The incision [illegible] and [illegible] on each side are continuous with the base of the large triangle and form the [illegible] side of the lateral flaps after they are undercut and moved.

Shows the process of removing the triangles of skin and raising the flaps which are undercut as far as the dotted lines.

Result obtained by sliding the flaps together and suturing the margins. (Davis and Traut in Lewis' Practice of Surgery.)

whatever. In some cases, they may protect tender, unhealed areas from contact with clothing. On a raw surface frequent application and subsequent removal of dressings at the more or less constant traumatism brought about by their presence, does a very great deal of harm: first, by keeping the skin edges in a moist, macerated and water-logged condition; second, by tearing away the epithelial new

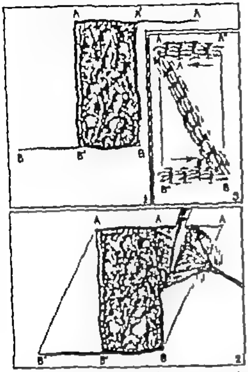


FIG. 297. Illustrating method of closing rather large rectangular defect by [illegible] flaps [illegible] from opposite sides of the defect and advanced to meet each other.

[illegible]

(Davis and Traut in Lewis' Practice of Surgery.)

growth thrown out for repair. Granulation tissue constituting the ulcer base becomes infiltrated with fibrous scar tissue, circulation suffers and the processes of repair are put to disadvantage.

Connolay treats certain types of wounds, particularly those of superficial nature showing tendency to delay in healing, by exposure to open air and sunlight; and, if the latter was not available, to the various types of electric light.

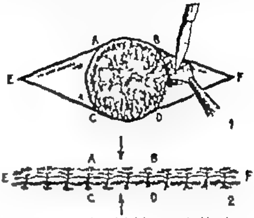


FIG. 298. Illustrating the simplest method of closing [illegible] defect [illegible] to be drawn together by [illegible]. (Davis and Traut in Lewis' Practice of Surgery.)

He points out that the contact of dressings of the usual type with any granulating surface causes [illegible] of serum, the so-called foreign body reaction. This reaction is most strikingly seen in the response caused by [illegible] drains, the profuse discharge provided quickly disappears for the most part soon after the removal of the offending body.

Mosquito-proof cloth and adhesive plaster is used to construct a screen or framework to be applied about the wound. The screen-wire is cut to the requisite size necessary to make an adequate shield over the wound. The edges are bound with strips of adhesive plaster and shaped so as to fit about the wound (Fig. 298). In many instances raw areas thus treated will heal in contradistinction to others that have been consistently dressed day after day without apparent diminution in the size of the wound. If the wound is deep, as a rule, this form of treatment is supplemented by the application of heat, as by sunshine or lamp,

[illegible] promotes healing by improvement of circulation as well as by the drying of the skin.

The position of the part involved often plays an important part in the healing process. If the wound is deep this form of treatment is not begun until the granulations are nearly flush with the surface. If the wound is superficial, such

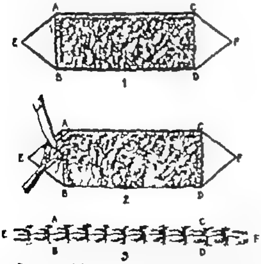


FIG. 299. Illustrating method of closing rectangular shaped defect [illegible]. (Davis and Traut in Lewis' Practice of Surgery.)

as that produced by removal of skin grafts for use elsewhere, the treatment can well be begun at once.

Skin Grafting

Skin grafting consists in completely severing a portion of skin or epithelium from one part of the body and transferring it to another part to correct a defect. It differs from plastic surgery in that the transplant used in plastic work is furnished with a pedicle through which it is nourished while uniting with the surrounding structures.

Skin grafting is often called "transplantation." The term "implantation"

signifies the use of dead organic or inorganic substances. The word "graft" should be used in describing transplantation procedures while the word "flap" should be used in connection with plastic surgery.

Epidermal grafts are made up of epithelium alone in either large or small pieces; dermo-epidermal grafts consist of epidermis and a part of the true derma; total cutaneous or whole-thickness grafts are made up of the whole thickness of the skin and in some instances including the subcutaneous connective tissue.

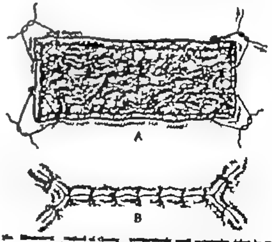


FIG. 300. Illustrating method of closing comparatively small rectangular defect by undermining the margins and approximating the edges with sutures.

A. Shows the defect with the sutures which are first placed at the four corners.

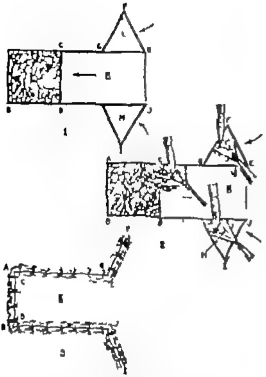
B. After these are tied, the other sutures are inserted [illegible]. (Davis and Traut in Lewis' Practice of Surgery.)

Vegetable grafting although appearing somewhat similar to skin grafting is really quite different. Vegetable grafts grow more as parasites while skin grafts become a part of the tissue into which they are transplanted.

Autodermic grafts are those obtained from the patient himself. Those obtained from another individual are called isodermic, homo- or heterodermic; zoodermic is the term applied to grafts taken from animals.

If zoodermic grafts were successful, they would be classed as the favorite method. However, results are rather uncertain following this procedure. Keeling classes it as a "laboratory experiment." Cabot contends they are absorbed and that even though they appear to be successful at first, granulations are sure to appear later. Nevertheless many cases have been reported where the procedure was followed by gratifying results.

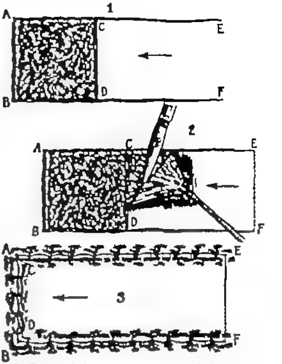
Out of [illegible] transplantations obtained from frogs, chickens, guinea pigs and rabbits, Cousin had [illegible] successes; out of [illegible] human grafts he reports successful results in [illegible] cases.



[illegible] Illustrating [illegible] procedure for closing [illegible] defect by means of [illegible] lateral flap and at the same time removing two triangles of tissue to facilitate the advancement according to Burow['s] method. [illegible]

There is [illegible] variation in the results obtained by the different surgeons in their experiments—some laud it highly, others condemn it.

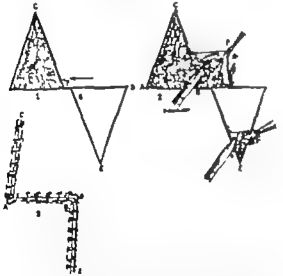
Medieval history records an instance concerning the transplanting of [illegible] graft from an animal to man which is quite remarkable. During the seventeenth cen-



[illegible] Illustrating [illegible] method of [illegible] defect by the use of [illegible] lateral flap [illegible] advanced and sutured. [illegible] French method [illegible]

[illegible] surgeon placed [illegible] bone graft from [illegible] dog in [illegible] defect in the scalp and skull of [illegible] after [illegible] had grown in place, he was forced to remove it, under threat of excommunication from the Church.

Skin from the frog furnishes perhaps the most successful zoograft. The skin from any portion of the frog['s] body may be used although that from the abdomen is usually employed. In 1884, Allen performed operations using this kind of graft. [illegible] and Dubousquet-Laborderie employed the method [illegible] few years later.



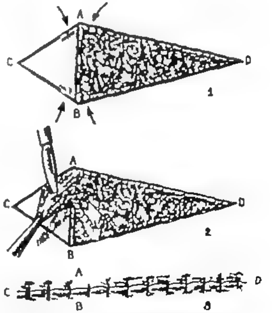
[illegible] Illustrating [illegible] method of closing [illegible] triangular defect [illegible]

The point [illegible] of the flap FCD [illegible] advanced and sutured to the point [illegible] and the point [illegible] to the point D. [illegible] (Davis and [illegible] Lewis' Practice of Surgery.)

The frog is prepared as follows: after scrubbing [illegible] immersed as far as the neck for five minutes in [illegible] solution of corrosive sublimate or permitted to swim in [illegible] boric acid solution for some time.

[illegible] may be wrapped in waterproof tissue [illegible] and preserved for several hours.

The new skin becomes translucent and pink, appearing as [illegible] film through which the red surface beneath can be discerned. The pigmentation disappears in [illegible] few days but the new skin still seems to be slightly darker than the surrounding skin.



[illegible] Illustrating the closure of [illegible] large triangular defect by the removal [illegible] triangle of skin [illegible] (Davis [illegible] Lewis' Practice of Surgery.)

Frog [illegible] skin must be given careful attention for at least three months, for although [illegible] soft, pliable covering [illegible] tendency to ulcerate and [illegible].

A certain degree of success was attained by [illegible] by using the skin from the undersurface of [illegible] chicken['s] wing.

An ulcer was successfully grafted with pieces of cock wattle by Alsambrano. Miles of Edinburgh grafted successfully the skin of a greyhound while Van Meter of Colorado employed the cuticle from a Mexican hairless puppy. The skin of a young pig was satisfactorily used by Raven and Habecker.

Miles also used the skin of rabbits and kittens, after shaving the abdomen or flanks of the animals, he removed the skin in strips ranging from 1 to 6 inches long and from one half to one inch wide. The edges of the grafts were placed

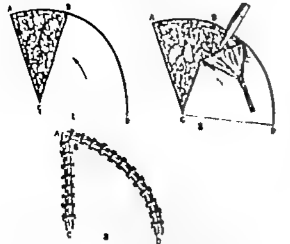


Fig. Illustrating a method of closing a triangular defect of considerable size by the use of a ... flap which ... the defect and ... Jacobs.

together and pressed down firmly being held in place by a dressing for forty-eight to seventy-two hours, after which it was carefully removed. If pustules have formed they should be opened. Granulations growing through the new skin which would tend to impair or destroy it should be removed with a sharp spoon. Out of 10 cases Miles reports 7 successes, only ... were complete failures.

Based upon the idea that the testicle possesses a greater degree of cellular activity than other parts of the body E. Alrock used thin pieces of the testes of rabbits for grafting purposes with good results.

The lining membrane of an egg has been used advantageously for grafting purposes in the care of extensive burns, injuries to the tympanum, conjunctiva or pharynx.

Tremble has reported excellent results using thin layers of skin from the shaved thigh of a young pig. Usually the skin is taken above the bristle layer should a few bristles appear they are of no consequence since the follicles in the graft soon atrophy. He reports 85 to 100 per cent of takes as against 30 to 75 per cent with other heterografts.

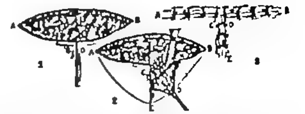


Fig. Illustrating a method of closing an elliptical shaped defect by the formation of two triangular flaps from the ... which are advanced and sutured.

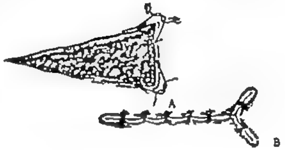


Fig. Illustrating the simplest method of closing a small triangular defect by undermining the edges and approximating the edges with sutures. (Davis and ... in Lewis' Practice of Surgery.)

Transmission of Disease

Diseases of different varieties may be transmitted in skin grafting from one person to another. Syphilis, tuberculosis, small pox and even cancer are said to have been transmitted in this manner.

General Condition of the Patient

It is not necessary for the patient to be in an extremely vigorous state of health before a skin graft is applied but he should be free from toxemia.

Fig. Illustrating a method of closing an angled wound. ... (Davis and ... in Lewis' Practice of Surgery.)

Where the patient has been suffering from erysipelas, grafts should not be undertaken until the disease has disappeared at least six weeks, for the streptococcus

Fig. Illustrating a method of closing an elliptical shaped defect by means of bilateral relaxation incisions and approximating the edges with sutures. (Davis and Traut in Lewis' Practice of Surgery.)

are likely to cause dissolution of the grafts before or even after adhesion has taken place.

Successful grafts have been made in the presence of nephritis and diabetes although they exert an unfavorable influence.

Surgeons do not agree as to whether grafts can be satisfactorily implanted in the presence of syphilis. A great deal depends on the stage of the disease and whether the area to receive the graft is syphilitic. A skin graft should not be placed over a syphilitic ulcer. There are cases recorded where grafts have been known to grow and heal where the patient was affected with syphilis.

REVERDIN GRAFTS

When J. L. Reverdin, an intern of La Charité, in Paris, on Dec. 8, 1869, made his famous report on the subject of skingrafting to the Société de Chirurgie, he instigated new interest in this phase of surgery when he informed his hearers that

Fig. Wire mesh and adhesive plaster used to ... protection for wound. (Courtesy Dr. John E. Cannady.)

pieces of skin, removed from their original connections, would adhere and grow on granulating surfaces.

Preparation of the Surface to be Grafted

When the granulating surface is healthy and the wounds fresh, little preparation is necessary. If, however, conditions are not so favorable more precautions should be taken.

It is quite possible for epithelium to grow on an unhealthy granulating surface, according to Bryant, many Reverdin grafts are applied in the presence of pus and some have been known to grow on cancerous surfaces. Naturally a healthy granulating surface is to be preferred.

Granulations should be of medium size, vascular and of a fresh red color not large and flabby. One of the best indications of fitness for the reception of grafts is the formation of a pellicle of new skin around the borders of an ulcer.

Excavated ulcers should be curetted. Cicatricial tissue often surrounds the margins of old ulcers, interfering with the vascular supply and rendering skin grafting difficult if not impossible.

If the circulation is impaired by varicosities or scar tissue, or if inflammations or complications are present, the patient should remain in bed a few days or until the part returns to normal. Moderate pressure evenly applied with sponge, is of great value.

When acute inflammation has been allayed, the granulations should be prepared for reception of the grafts. This may be accomplished by cauterization and compression (stick nitrate of silver or tincture of iodine). Cauterization should be done every two or three days. Iodoform gauze saturated with balsam of Peru sometimes does good service (Fromme).

Induration and fibrous thickening of the borders are treated by making few radiating incisions through the ring of callus down to the softer tissues; this relieves tension and promotes vascularity. Heliotherapy is sometimes of value.

In order not to injure the vitality of the grafts, any strong antiseptics which have been used for cleansing should be washed away before transplantation is done.

Grafts

The inside of the arm or thigh, or the side of the chest or bend of the elbow is considered best. In these structures the skin is thin and soft and comparatively free from hairs or glands.

Lucas considers that "the prepuce of a child possesses a greater vitality which renders it peculiarly serviceable for grafting. In addition to suppleness, thinness, and vascularity, He claims that prepucial grafts will adhere when those from other parts fail, even on unhealthy granulating surfaces."

Reverdin recommended originally that the grafts should be small, that is, about the size of a grain of wheat, thus reducing to a minimum the pain and the scars occasioned.

The removal of grafts from the donor is most easily done by raising a small fold of skin with a pair of mouse-tooth forceps and dividing it with a scissors, knife or razor. Iridectomy scissors are useful. Obtain all of the epithelium and part of the corium. Include no subcutaneous cellular tissue or fat. The epidermis is all that is really necessary although it is well to include part of the corium. Reverdin employed the term "greffe dermique" which Poncet changed to "greffe dermo-épidermique" thus more correctly expressing what is really meant. A small amount of blood oozes.

The skin may be partially frozen with ethyl chloride or anesthetized with novocaine although the pain is very slight. In case the skin is partly frozen, the grafts may be all cut at once and placed in warm salt solution until required or they may be preserved on a warm piece of glass, raw side down. The small elliptical wounds heal quickly. No sutures are necessary. An ordinary aseptic or antiseptic dressing may be applied, dry or moist, which serves to prevent the development of infection.

Marcy has shown that satisfactory grafts may often be cut by pressing a pair of curved scissors firmly against the skin and snipping off the portion which protrudes between the blades. Some prefer to elevate a fold of skin by transfixion with a fine needle but this offers no advantage over forceps.

Souchon has recently emphasized an old and useful method of obtaining small grafts by cutting them with scissors from the skin, new epithelium as it "flows" out from the skin-edges of a healthy granulating surface which is beginning to heal.

Grafting

After being cut the grafts are immediately placed upon the surface to be grafted with a forceps or needle with their raw sides down. Curled edges are carefully straightened with a probe. If no blood or other fluid is present, attachment immediately takes place. Slight pressure with a dampened gauze pledget is helpful. Roberts and others claim that exposure of the ulcer to the atmosphere before and after operating is helpful by causing it to become sticky thus facilitating adherence.

Each graft is capable of some expansion but it cannot stimulate the borders of the ulcer effectually farther than half an inch. If a single graft is placed in the center of a very large ulcer it will form an island of skin only. Therefore, the transplants should not be more than half an inch apart. They need not be placed in rows or geometrical figures. If only a few grafts are available it is better thoroughly to cover a small area than to scatter the pieces too far apart (Figs. 589, 590, 591.)

Dressings

Place rubber protective next to the grafts, thus preventing their adherence and displacement when the dressings are changed. This should be cut in strips half an inch wide which are placed side by side, or criss-crossed, like basket-work, or punched full of holes which serve as outlets for secretions. Strips of transparent gutta-percha are useful here; their ends should project onto the sound skin; adhesion will take place if they are dampened with chloroform. If the gutta percha is not available, gold beater's skin, oiled silk, tin-foil, silver foil, etc., may be used. Ordinary adhesive plaster is preferred by Marcy. Any of the above methods may jeopardize the vitality of the new skin by causing maceration. A superior method which is much simpler consists in spreading a single layer of gauze over the grafted surface and fastening it to the skin with collodion. This is recommended by McCarthy and Fromme.

If a dusting powder is used, care must be taken that it does not form a crust, beneath which pus may accumulate and destroy the grafts. If a wet dressing is used, moist the powder or salve. gauze and saturated with boric acid solution or normal salt solution (warm) instead. If a covering of oiled silk is placed over the dressing, it will be unnecessary to moisten it oftener than once every twenty-four hours.

It would be unnecessary to change the dressing during the healing process if the operative field were always aseptic. Since there is always a certain amount of suppuration, it is advisable to change the dressing every 24 to 48 hours. The wound may be gently irrigated but never rubbed for fear of injuring the transplanted skin.

If the discharge has been profuse and protective has been used it should also be frequently changed. If little suppuration is present, however, it may be left in place for 5 or 10 days.

Bacillus pyocyaneus sometimes causes the dressings to become green; this, combined with the unpleasant odor which is often present may needlessly occasion some alarm.

The "open method" may be used in place of the different dressings. This

consists in exposing the graft to the air beneath a protecting wire-gauze cage. If a great deal of suppuration is present, the formation of thick crusts is likely to render this procedure unsatisfactory.

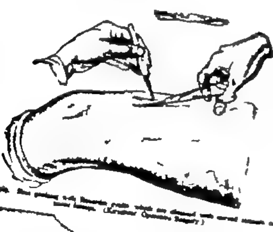


Fig. 589. Skin grafting with Reverdin grafts which are clipped with curved scissors out [illegible]. (Kirschner Operative Surgery.)

Fig. 590. Reverdin patch grafts.

When grafting is done over a joint, especially in children, the part should be immobilized by the application of a splint. The lower extremity should be elevated to promote circulation.

Process of Healing

The grafts appear to swell, becoming whiter, thicker and softer during the first 24 hours. In two or three days those which adhere become pink and are surrounded by a reddish areola. Following this a grey epithelial pellicle emerges from their margins and the connecting borders of the ulcer. The pieces of skin which turn brown are dead while those which turn a yellowish white lose their superficial layers of epidermis as the deeper layers remain that which is lost is soon reproduced.

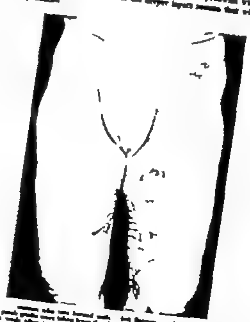


Fig. 591. Woman who was burned with [illegible] ... on the inner surfaces of both thighs. The pinch grafts were taken from the abdomen and transplanted over the affected area. Condition two weeks after transplantation.

At first, the new epithelial pellicle is not fastened to the granulations. It simply rests like tissue-paper upon the surface from which it may be raised. After some rootlets grow down into the granulations, securing the epithelium and connecting the grafts together and to the edges of the ulcer.

The part must be carefully protected for several weeks after cicatrization until a certain amount of resistance has been attained, as ulcers thus treated have

tendency to break down upon the slightest provocation. A soothing ointment may be used to combat any tendency to dryness or exfoliation.

The new skin is quite inferior to normal skin although it is better than scar tissue. It is without hair bulbs, sweat glands or sebaceous follicles. In time certain amount of sensation is regained.

THIERSCH GRAFTS

As regards priority, Ollier[1] was in the habit of cutting grafts ·1 to ·3 mm. wide and 1 to 4 cm. long, resembling in every way Thiersch grafts; but unlike Thiersch, he did not scrape away the granulations before making the transplantation. Fischer[2] also shaved from the surface of a limb, thin strips of skin identical with those used by Thiersch.

This superior method of skin grafting has never received the recognition to which it is entitled. Fresh wounds or granulating surfaces of almost any size may be covered with epithelium in from ten days to three weeks; scar contractions are prevented; infections are avoided and the cosmetic result cannot be too highly praised.

Preparation of the Surface to be Grafted

Scrub the skin. Remove the débris (crusts) and surrounding hairs and irrigate with normal salt solution. Anesthetize the patient. Curet the surface. Check oozing with firm pressure.

Grafts

The grafts are best obtained from the anterior surface of the thigh. Cut them with a sharp razor. An assistant renders the surface tense by means of a hand on each side of the limb or by grasping the thigh from below, while the surgeon, taking his position with his back to the patient's feet, cuts toward himself while his left hand is used to stretch the skin in front of the razor toward the knee. Pieces of gauze beneath the hand help in obtaining a firm grip. Thin pieces of epidermis are removed by means of a side-to-side sawing motion. The pieces may be several inches long and range from one-half to one inch wide. Keep the skin and razor wet with salt solution. (Fig. 392.)

It is unnecessary to remove the whole thickness of skin; all that is required is a paper-like layer with several bleeding points caused by dividing the capillary vessels in the papillary ends. Beginners will do well to practice skin grafting on the cadaver first, before attempting it on a patient.

As the strips of skin are cut they fold up on the razor and when sufficient length has been obtained, slightly incline the instrument away from the thigh thus severing the graft from its connection.

Grafting

Place the grafts on the surface prepared for them shingle-wise—that is, overlapping each other as well as the wound edges. If the pieces are large they may be buttonholed with a scissors or perforated with a punch for drainage purposes. If there is a redundancy of skin the extra portions may be replaced upon the surface from which they were taken.

[1] Bull. de l'acad. de Méd., 1872.
[2] Deut. Chir. Bd. 1886, 119.

BLEEDING

In controlling the bleeding which often follows the curetting, Thiersch first used an Esmarch constrictor, leaving it in situ until grafts and dressings were applied, but later considered this procedure erroneous. Others, however, have used it extensively. There seems to be no logical objection to the use of a constrictor although its removal is usually followed by an undesirable oozing.

Pressure with gauze pledgets moistened with peroxide of hydrogen or adrenalin solution is useful for controlling bleeding, particularly if the part is elevated; or pressure is applied over a piece of rubber protective thus avoiding tearing the clots from the mouths of the small vessels when the dressing is removed. Rosenberg recommended the use of a high-frequency electric current for coagulating the blood and promoting the adherence of the graft. This has not proved very popular, however. It is better to twist a vessel than to ligate it. A dry surface should be maintained in order to promote the growth of the new skin.

CURETTING

Curetting was one of the principal features of Thiersch's original procedure. It was his idea that the large, soft, superficial granulations, during their transformation into connective tissues, were the cause of scar contraction which could be avoided by curetting down to the firmer tissue. Schmieder and Ewald proved it was unnecessary to remove healthy granulations, and that the graft may be placed on the uncurefted surfaces without fear of any great amount of contraction. Reliable results have been obtained without curetting but diseased tissues should always be removed. In any case results are likely better when the granulations are removed.

Beck rubs the granulations away with gauze instead of using a curet. Halsted, McBurney and others preferred to shave the surface with a scalpel or an amputating knife. In this way a smoother surface is obtained thus promoting the vitality of the transplant.

Irrigations of warm salt solution or sterilized water are advisable during and following the operation.

Thiersch and others advise against using antiseptics after curetting, stating that the resulting necrosis interferes greatly with the anchoring of the grafts; however, they may be used both before and after curetting if they are washed away with a neutral solution. Their value is doubtful.

After-Treatment

Grafts become firmly fixed in from 7 to 10 days. The innermost layer of dressing material may be left in place for two weeks under ordinary conditions. The coverings should be soaked off with warm salt solution to avoid injuring the grafts, although in some instances this is not necessary as the dressings slide off very easily.

The part covering the graft should be protected from injury and sudden temperature changes for several weeks, especially in the case of ulcers which have a tendency to recur after grafting. Some mild soothing ointment should be applied to the part to prevent dryness and cracking.

In many cases, especially where wet dressings are employed, the external

layers of epidermis slough and become macerated and seem to come away with the dressing when it is removed leaving a grayish, moist surface behind. This is not always indicative of failure for in a short time the epithelium will be replaced from the remaining rete Malpighii.

Schmieden and others are of the opinion that scarlet-red ointment promotes the growth of epithelium greatly. It may be employed advantageously in Thiersch grafting where the whole area has not been covered by skin. It is recommended that the ointment does not come in contact with the graft unnecessarily as it is likely to destroy.

THE WOLFE-KRAUSE METHOD

J. R. Wolfe, an oculist of Glasgow, introduced the method of using grafts to fill the entire defect in the skin including the whole thickness of the skin but without adipose or cellular tissue (Figs. 393–394). He first experimented with the conjunctiva, shifting parts of it from one part of the eye to the other without pedicles. Later (1875) he employed the conjunctiva of rabbits in treating defects in the human eye. Three years later he made public his experiments in skin grafting for ectropion. In a short time Wadsworth introduced the method in America. Von Esmarch was the first to use the procedure extensively in general surgery.

Grafts comprising the whole thickness of skin had been used often before the time of Wolfe but in nearly all instances the subcutaneous tissues were also included. Jacenko may have been the first to use grafts without fat satisfactorily. In 1872 Le Fort reported success in treating a case of ectropion.

Wolfe contended that the fat should not be included in the graft on the basis that it was likely to undergo necrosis and interfere with nutrition, and he was doubtless correct. Bunchberg and Taylor as well as many others do not conform with this belief since transplants of fat alone have been grafted from one place to another to fill in depressions or as a substitute for the mammary gland. The original method of Wolfe has been modified and improved upon by Fedor Krause to such an extent that it is generally called the Wolfe-Krause method.

Grafts

The grafts may be cut in the form of an oval or spindle so that the defect left may be closed by sutures. The arm, thigh or buttocks may be chosen. It is of little moment where the grafts are obtained. Davis suggests using skin from the abdomen in the course of a laparotomy.

Outline the graft by an incision. Dissect the whole flap with a knife, the edge of which is turned toward the surface so as to remove the fat. Allow at least one-third for shrinkage (this is always great (elasticity of the skin)).

Young advocates the removal of the subcutaneous fat with the grafts, trimming it off later with curved scissors while the flap is spread on the palm of the hand or is curled over a finger. He contends this is a quicker, easier method and the remaining defect is more readily closed.

According to Krause, absolute dryness is an important factor in promoting quick healing. The hands and instruments should be kept dry and no irrigations should be done. Others do not agree with him.

The entire wound should be completely covered with as large sections of skin as it is possible to obtain, because where there is an open space a scar

Fig. 392. Thiersch graft. A, granulations being flattened ... after breast amputation; B, strip of skin removed from thigh; C, placing the graft on wound; D, wire basket protector.

results. It may be necessary to complete the operation with Thiersch grafts.

Originally artificial heat was used to keep the new skin warm: this was discontinued when it was found to promote decomposition.

A dry gauze dressing is applied.

After three or four days it is advisable to soak the gauze off with boric acid solution, examine the graft and open any blisters which may be present. Apply sterilized borated vaseline.

SIEVE GRAFT

Beverly Douglas describes a "sieve graft" for covering large skin defects[8] as follows:

"This large graft has been called the 'sieve graft method' because the graft is uniformly perforated with small round openings. The method provides firm safe healing without contracture in a defect upon any portion of the body. The cosmetic result accomplished is very nearly as good as that obtained by the Wolfe-Krause graft.

Fig. [illegible]

Fig. [illegible]

Fig. [illegible]. [illegible] of plantar fascia.

Fig. [illegible]. Skin grafting (Wolfe-Krause method) following removal of tumor of foot. Graft [illegible] taken from [illegible] of daughter of the patient. Excellent final result.

Prepare the wound to be grafted in accordance with Blair's method. Outline a pattern on transparent cellophane with a pen on the day before the operation. This should be about one-fourth larger than the wound to be covered; transfer to rubber and punch the letter "F" near the lower border for the purpose of orientation. The usual antiseptic preparation is made at time of the operation. General anesthesia is recommended although local analgesia may be employed. As a rule, four lines of intradermal infiltration are made outlining the pattern: this is supplemented by an injection of 5 cc. of the anesthetizing solution subcutaneously at eight points equally spaced within the area to be lifted. In the presence of small varicose vessels, more infiltration is necessary.

The "sieve graft" technic takes no longer than an ordinary full thickness graft, if the closure of the donor wound is included with which the "sieve" method entirely dispenses.

Step 1. Place the bed pattern upon the donor skin site. *Follow its periphery* with a scalpel cutting through the skin just to the fat. The [illegible] used the smaller is that illustrated in Fig. [illegible].

[8] [illegible] Jour. [illegible], Vol. [illegible]. [illegible] Ann. Surg. [illegible].

Step [illegible]. Twist the steel die with the thumb and index finger boring out islands of skin equidistant from each other over the graft area. The die is one-fourth of an inch in diameter and its flange is one-sixteenth of an inch deep. The surrounding skin is tensed while each island is being bored. Make the openings one and one-half cm. apart.

Step 3. Insert the point of a sharp pointed narrow bladed scalpel into the incision made by the punch for each island (Fig. [illegible]), a, keeping just the full thickness of the skin until its point comes out through the punch incision to the left of it but over the top of the corresponding island, b. With a sawing motion it is advanced to islands, c and d, the skin surrounding which is similarly undercut. Reverse the blade and complete the [illegible] degrees of the circle from b to [illegible] to d in the same way. As the scalpel enters each circular punch incision, have an assistant depress each island with a knife handle or other suitable instrument to prevent its injury. When each opening is undermined, undermine the peripheral edges of the graft in the usual manner and cut through a few strands of tissue previously overlooked, thus liberating the entire sieve graft. The donor site will still present small islands of skin spaced within the fat and fascia (Fig. [illegible]). Apply vaseline gauze over which dry gauze is strapped with adhesive.

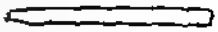


Fig. [illegible]. Steel die used [illegible] sieve graft. (Courtesy, Surg., Gynec. and Obst., vol. [illegible], [illegible].)

Fig. [illegible]. Undermining skin in sieve graft. (Courtesy, Surg., Gynec. and Obst., vol. [illegible], [illegible].)

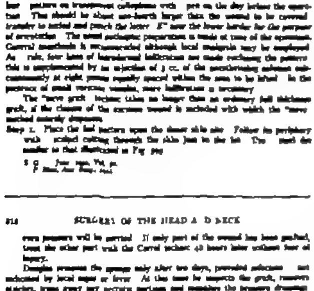
Step 4. Remove all fat from the graft with curved scissors and suture it into the wound with interrupted stitches of silkworm-gut or horsehair. *Approximate the edges accurately* (Fig. [illegible]). Dress the grafted area in accordance with Blair's sea sponge technic. Press the graft into contact thus expressing all serum and blood clot. Cover with a layer of xeroform, vaseline gauze-mesh or ordinary vaseline gauze wiped until very little vaseline remains on it. Over four layers of dry flat gauze apply large flat sea sponges which have been sterilized in bichloride and wrung out in dry towels just before using. If possible one *sponge should cover the entire area extending well over the suture line, thus*

Fig. [illegible]. Small islands of skin left on the donor site and healed. (Courtesy, Surg., Gynec. and Obst., vol. [illegible], [illegible].)

even pressure will be exerted. If only part of the wound has been grafted, treat the other part with the Carrel technic 48 hours later without fear of injury.

Douglas removes the sponge only after ten days, provided infection is not indicated by local signs or fever. At this time he inspects the graft, removes stitches, trims away any necrotic portions and reapplies the pressure dressing. Within [illegible] to 18 days the perforations will have been found to be epithelialized and pressure may be discontinued.

A longer time is required by the islands for healing but they heal with certainty and a pigmented epithelium will result. These islands have the appearance of small deep grafts but should not be confused with them, as they have not been



A [illegible] C

Fig. [illegible]. The ulcer [illegible], the graft [illegible] place, and the graft healed. (Courtesy, Surg., Gynec. and Obst., vol. [illegible], [illegible].)

undercut and hold their position strongly. The epithelium from them has great healing power. It is not necessary to attempt closure by undermining the edges of the wound, etc., as satisfactory healing with almost full pigmentation is bound to take place.

Comment. According to Douglas, the ideal graft for filling large skin defects must possess the following properties:

1. It must be capable of living so that its removal will leave behind a wound which will heal rapidly without further grafting and with only slight scarring.
2. It must be able to take hold and grow upon a moderately infected surface.
3. It must provide complete healing in a reasonably short time.
4. It must inhibit scar formation and subsequent contracture—a point especially important in defects over joints.
5. It must produce a skin surface so pliable that healing is stable and resistant to minor injuries.

6. It must effect a good, though not necessarily an excellent, cosmetic result.

Weighing each of the types of grafts in general on the basis of these points, Douglas' experience is as follows:

1. The Ollier-Thiersch graft fails from the standpoint of resisting infection and of preventing contraction, and the surface healed by its employment is easily eroded.
2. The small deep graft is ideal from every standpoint but two, viz.: it fails to prevent contracture and often fails to give a good cosmetic effect.
3. The Wolfe-Krause or full thickness grafts are excellent from the standpoints of stable healing, cosmetic effect, and prevention of contracture. However if the graft is large, a defect is left behind at the donor-site which will require further grafting—a distinct disadvantage. Furthermore, infection may readily cause its total loss.

The sieve graft satisfied all of the demands enumerated. Two valuable properties possessed by none of the above varieties deserve especial mention: (a) the perforations, by providing adequate drainage, make it resistant to infection, thus ensuring a very high percentage of takes; (b) the donor site requires no further grafting and heals with a good cosmetic result.

Dragstedt and Wilson: Modification of the Douglas Sieve Graft

L. R. Dragstedt and H. Wilson[9] point out that the Douglas method of placing the graft was so devised as to leave behind numerous small islands of skin from which regeneration could occur making it unnecessary to treat further the donor-site. In other words, it retained the advantages of the Wolfe-Krause full thickness graft in preventing contracture and providing a new skin surface resistant to minor injuries while also affording a higher incidence of takes especially in the presence of mild infections.

The Dragstedt and Wilson procedure retains the advantages of the perforated full thickness graft of Douglas while it greatly facilitates healing of the donor-site. Besides, the graft is easier to prepare, does not require any special instruments and the procedure consumes much less time.

Step [illegible]. Prepare the wound to be grafted in the usual manner.

Step [illegible]. Secure an oval shaped transplant (Fig. [illegible]) the full thickness of the skin with none of the subcutaneous fat. The long axis of the graft should be about one-third longer than the long axis of the wound to be covered. The graft is taken from the lax skin of the abdominal wall. No undercutting is usually necessary.

Step 3. Place the graft, dermal side down, on a smooth towel moistened with physiological salt solution.

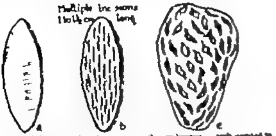
Step 4. With a sharp scalpel make numerous short longitudinal incisions (Fig. [illegible]). These incisions should be overlapping. When this step is completed it permits the graft to be stretched into any desired shape (Fig. [illegible]). Fenestrally the graft need not be more than one-third to one-half the width of the defect to be covered.

[9] Surg. Gyn. & Obst., Vol. [illegible], [illegible], July [illegible].

Step 5. Suture the transplant into place and press it firmly in contact with the underlying raw surface. (Fig. [illegible])

Step 6. Cover the graft with [illegible] gauze which is covered with flat gauze and wet sponges. ([illegible] method of wet-sponge compression.)

Comment. Remove the sponges on the seventh day. Inspect the graft. Remove the stitches. Reapply the compression dressing for another week. Follow this by ordinary dressings. The donor-site usually heals within a week or ten days.



[illegible]

SKIN-PERIOSTEUM-BONE GRAFTS (HIRSCHBERG)

[illegible]

MUCOUS MEMBRANE (WÖLFLER) GRAFTS

[illegible]

[illegible]

GRAFTING IN X-RAY BURNS

[illegible]

TREATMENT OF BURNS

The causes of death in burns and scalds are:

(1) Shock which is often accompanied by pulmonary congestion and [illegible]

(2) Collapse which may prove fatal and

(3) Toxemia resulting from sepsis.

[illegible]

First Aid

[illegible]

replaced by double the amount of donor blood. Transfusion of normal saline and hot drinks are also a great aid.

Coagulum

Mitchener advises in order to prevent the growth of molds in the tannic acid solution, to add very weak perchloride of mercury. The molds then gradually decompose to oxide of mercury. No solution should be more than two months old.

Tannic acid powder is only slightly antiseptic. It will not deteriorate if kept in the dark. In watery solutions molds rapidly appear unless an antiseptic be added to the solution. The antiseptic used must be nontoxic and produce no pain to the patient; it must not interfere with the coagulative action of the tannic acid but must stop the growth of the mold. Mitchener states:

"Many antiseptics have been tried, and personally we favour perchloride of mercury in itself a coagulant and used in treating burns by Lord Lister. Added in such a strength as to give a solution of 1/1,000 it is harmless to the patient, and allows solutions of tannic acid to keep free from moulds for at least two months, and usually three; the perchloride slowly decomposes to yellow oxide of mercury which is deposited out of solution. In conjunction with tannic acid powder the perchloride of mercury keeps indefinitely. Many coal tar antiseptics have been tried, but most of these are painful to the patient in a greater or less degree, and in addition may interfere with the formation of a firm coagulum. Acriflavine and dettol have both been used successfully though in both cases slight pain is often experienced. A new compound combining acriflavine and zinc phenolsulphonate is, however, quite painless and gives a good coagulum. It has, however, the disadvantage of all flavine compounds that it stains everything bright yellow. These solutions appear to keep indefinitely and are quite harmless. Tannic acid should, therefore, be combined with an antiseptic, and may be kept in a solid form or in solution."

The Tannic Acid Compress

Five or six layers of sterile gauze are cut to the required size and should overlap the apparent limits of the burn by at least 3 inches. If the burn involves fissures between fingers, etc., the dressing must be shaped carefully to fit closely to these.

Soak the dressing in [illegible] per cent tannic acid solution. Apply the dripping dressing evenly to the whole affected area, great care being taken to see that accurate apposition is accomplished. Flannel is now applied, binding the dressings gently but firmly into position. Put a cradle over the burnt area; an electric lamp will assist drying. Keep the temperature of the room around [illegible]° F. or [illegible]° C. The dressing should be hard in 24 hours. Inspect the dressing but do not touch it unless indicated (pyrexia, toxaemia, etc.), then redress and redress the affected area. Slight exudation of serum or sero-pus around the edges of the dressing is no indication for redressing. The dressing is not to be touched until the coagulum separates from the injured area. This usually takes about 12 days in small burns and 18 in large ones.

Most persons suffering from severe burns are in a state of shock which should be combated first.

Modern Treatment of Burns, [illegible] Ward, [illegible]

Intravenous injections of saline are often effective in counteracting the toxemia caused by burns. Sponge the uninjured skin with cold water. Give, per os, alkaline preparations to relieve acidity which often accompanies severe burns.

In the extreme cases where it becomes imperative immediately to neutralize the toxin in the blood stream, exsanguination-transfusion is resorted to. The procedure consists of first bleeding the patient and then performing a transfusion from a donor correctly typed. The quantity of blood withdrawn varies from 100 cc. in infants to 1½ pint in adults, while the amount of blood transfused ranges from [illegible] cc. in the infant to [illegible] pint in the adult.

Tannic acid has been widely used for the local treatment of burns since its introduction in 1925 by E. C. Davidson. It forms a very fine protection for the injured area and prevents toxemia. The coagulum covers the exposed nerve ends, thus preventing pain. Tannic acid fixes proteins and their metabolites thus locking in the coagulum those which would otherwise find their way into the circulation. In other words toxemia, the "false wall" of burns, is much less likely to take place when tannic acid treatment is instituted. This treatment may be begun as late as seventy-two hours after the burn has been sustained.

It is important that no water comes in contact with the tanned (leathery) coagulum which forms when tannic acid is applied to the burned area. If this precaution is not observed, toxins will be liberated which may result in death. Bettley records such a catastrophe.

To prevent sepsis and scarring, the affected region should be thoroughly cleansed under a general anesthetic.

PREPARATION OF THE TANNIC ACID SOLUTION

A 5 per cent solution of tannic acid in 1:1000 acriflavine seems to be best. Dissolve about a teaspoonful (1 ounce) of tannic acid in five ounces of 1:1000 acriflavine in water.

The Tannic Acid Treatment is carried out as follows:

Step 1. Puncture the blisters and trim away the loose epithelium.

Step 2. Render the burnt area aseptic by scrubbing it as well as the adjacent region with liquid green soap.

Step 3. After applying some good antiseptic to the burnt area, dry it with sponges soaked in ether.

Step 4. With a sponge or brush apply the [illegible] per cent tannic acid solution. Dry it by fanning. An electric hair drier may be useful here.

Step 5. Cease giving the anesthetic after the injured region turns a golden brown. However, apply three or four more coats after this, drying each one separately.

The patient is now placed in bed on a sterile sheet and the burnt area is covered with a sterile towel over which a cradle is placed. Great care should be taken to see that the area is kept dry at all times.

Further coats of tannic acid are applied daily until the coagulum becomes hard and black. Dressings are then discontinued. Healing takes place under these coats of tannic acid and they are left in place until they peel off spontaneously which in the usual case is from 10 to 14 days. After the covering is removed, apply vaselined gauze and bandage. Skin grafting is necessary in some cases.

Figures [illegible] depict the treatment of an extensive burn of the shoulder treated by skin grafting with superimposed pressure and body cast spica.

Comment. Donald B. Wells[1] submerges the burned patient in a large tub of tannic acid solution which is renewed when fouled; it is kept at a temperature comfortable to the patient. All debris, blisters, etc., are carefully washed away, the astringent effects of the tannic acid rendering this painless. After about three hours, when the entire burned area is clean and a slight tan has already formed, the patient is transferred to bed and kept absolutely dry by the air from one or more large, commercial hair

Fig. [illegible]

Fig. [illegible]

Fig. [illegible]. Extensive burn of the shoulder and neck treated by skin grafting with superimposed pressure and body cast spica. Plaster of Paris [illegible] for purposes of rest and [illegible].

Fig. [illegible]. [illegible] (Hospital [illegible], Cook County Hospital.)

driers. A [illegible] to 5 per cent solution of tannic acid is now sprayed on, a small area at a time so that each is dry before another is started. All blisters are broken. After a thick coagulum is formed the spraying is stopped, but the driers are continued so that not even perspiration can soften the pure plane. The author has never had to follow this treatment by skin grafting nor has he had any infection as long as the coagulum was kept perfectly dry.

In the treatment of burns about the head and face, evipan (as under anesthesia) or ether may be advantageously used. Eye pads and small plugs of cotton soaked with saline are employed and the face is rendered antiseptic in the manner described above.

[1] Wells, Donald B., Jour. Amer. Med. Assn., [illegible]

LIST OF AUTHORS

(Pages in bold face type denote pages on which an author's operative technic is described.)

SUBJECT INDEX

VOLUME II

Part III

SURGERY OF THE NERVES, VESSELS AND BONES

ORIENTATION

The absorbing field of surgery of the peripheral nerves and the engaging problems of the surgery of the sympathetic nervous system are taken up in Chapters 19 and 20, respectively. In the latter particularly many obscure problems are gradually being clarified. Notable advances have been made, the result of the impetus given by [illegible], Jonnesco, Leriche, Adson, [illegible] and others. The surgery of the blood and lymph vascular systems are discussed in Chapter [illegible] beginning with Lambert's arteriorrhaphy ([illegible]) to [illegible] analysis of the work of Rudolph Matas and that of Pierre Delbet; thus, in order to evaluate the methods used in the past in the surgery of aneurysmal dilatations and the conclusions arrived at after many decades, yes, centuries of surgical endeavor. The conclusions here are interesting and instructive. It is regrettable to note the paucity of information accorded in some textbooks on surgery to the subject of ligation of arteries.

Orthopedic surgery is taken up in Chapters 22, [illegible] and 24. No attempt has been made here to present [illegible] on the methods used for the correction of [illegible] defects, congenital anomalies, tendon transplantation, etc. In passing I wish to recall that if success is to be attained in tendon transplantation, reduction of the deformity with over-correction must be accomplished first. Many surgeons has suffered [illegible] blow to his reputation and many [illegible] patient has paid with permanent deformity or incapacity the price of improper management of fractures. It is, therefore, imperative that the general surgeon be conversant with modern methods in vogue in the treatment of fractures and dislocations. Never trust to the fluoroscopic image to make [illegible] diagnosis. It is misleading. The greatest pitfalls lurk in green stick fractures and subperiosteal fractures and in so-called "sprains" which upon close examination are found to cloak unrevealed fractures.

The unbridled use of Roentgen's discovery has revolutionized diagnosis. It has made obscure conditions simple but [illegible] also tempts the young surgeon to place too much confidence in the x-ray, often to the neglect of developing his own diagnostic acumen and of his special senses. This is regrettable. The x-ray, while having brought about greater success in the recognition of fractures and dislocations, has also taught us that many methods of treatment heretofore resorted to were inadequate or imperfectly understood. Nevertheless, too many fractures are being operated upon where proper conservative management would yield better anatomic and functional results.

In Chapter [illegible] amputations and disarticulations are discussed. The modern views and methods of amputations and exarticulations have been pointed out while the time-honored methods of ablating portions or all of an extremity which originated in the days before anesthesia and Listerism, have been given historical consideration. Some old operations (Chopart, [illegible], [illegible], [illegible] and others) have stood the test of time and are still resorted to by some excellent surgeons—hence they may be still considered modern.

CHAPTER 19

SURGERY OF THE PERIPHERAL NERVES

Exploration of peripheral nerves is of greatest importance to determine the extent of injury or degeneration of [illegible] nerve and define indications for the proper treatment in [illegible] given case. Various tests (motor and sensory by means of electrical currents) are used for the purpose. The function of [illegible] peripheral nerve may be severely interfered with or completely suspended by compression from cicatrices, exuberant callus formations in fractures and various adhesive processes. Such compression may be temporary (physiologic) or permanent (anatomic); in the latter case the nerve has been divided.

OPERATIONS ON THE NERVES

NEUROLYSIS

This operation was first performed by [illegible] and by Ollier in [illegible]. The former liberated [illegible] nerve, compressed by scar tissue, the latter freed the nerve from compression of [illegible] callus.

The operative procedure consist of liberating [illegible] compressed or adherent nerve and of providing [illegible] new bed for the freed nerve and often of surrounding it with some material for the purpose of preventing reformation of scar tissue.

Capsulectomy

When the thickened sheath of [illegible] nerve is dissected free with its scar encasement, capsulectomy is spoken of. The operation consists of (Fig. [illegible]):

Step [illegible]. Exposure of the affected nerve above and below the point of compression.

Step 2. Careful dissection and liberation of the affected segment of the nerve. Avoid injury to the nerve during the performance of this step of the operation.

Step 3. Place the liberated nerve in [illegible] newly prepared vascular bed, preferably an intermuscular plane. If the nerve has been compressed against [illegible] bone [illegible] layer of muscle or other soft structure is interposed between the nerve and the bone. Some surgeons surround the nerve with avascular tissue such as Cargile membrane, fat, blood vessels hardened in formalin (Foramitti method). This is undesirable (Babcock). "Unbruised neighboring muscle forms the best bed for [illegible] liberated nerve and should be used whenever possible" (Dean Lewis). Fat, when transplanted, is said to be replaced by connective tissue that may interfere with vascularization of the nerve. On the other hand, [illegible] experiments tend to prove the value of transplanted fat.

Step 4. Suture of the wound. No drainage.

[illegible]

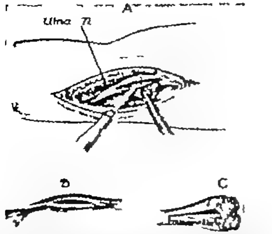


FIG. [illegible]. Cicatrectomy. A, removal of thickened sheath of nerve with adherent scar tissue. B, [illegible]. C, [illegible]. (After Dean Lewis.)

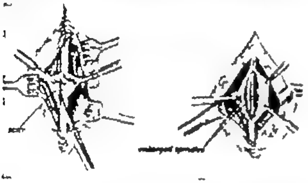


FIG. [illegible]. FIG. [illegible].

FIG. [illegible]. Transplantation. [illegible] (After Dean Lewis.)

Comment. Strict asepsis is essential for success in this form of surgical procedure.

Nerve suture done within one or two months after the initial injury offers the best prognosis (according to some authors close to 100 per cent). After six months the prognosis is much less favorable; after [illegible] year about [illegible] per cent of good results may be expected; after that period the chances for success are slight.

Individual nerves differ in their power of regeneration; thus suture of the brachial plexus and of the radial nerve should, according to Kirschner, give an average of [illegible] per cent good results, the median nerve [illegible] per cent, the ulnar nerve [illegible] per cent, the sciatic and tibial nerves [illegible] per cent, the peroneal [illegible] per cent. Return of function may be early (usually after about three months). If after two years there is no return of function the prognosis is bad.

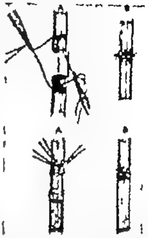


FIG. [illegible]. Nerve suture. [illegible] (After Dean Lewis.)

Endoneurolysis Neurolysis (Babcock)

This consists of [illegible] or the dissociation of the fibers of the peripheral nerve. This procedure was introduced by Babcock in [illegible]. It is used when nerve-conduction is interrupted by conditions within the nerve sheath not sufficiently severe to require the excision of the diseased segment with end-to-end suture. It finds its greatest field of usefulness in thickenings of the nerve sheath, interneural [illegible], limited fibrosis and in partial [illegible]. The term is applied to [illegible] variety of operations ranging from longitudinal splitting of the epineural sheath to dissociation of its fibers so that finally the [illegible] nerve is transformed into a [illegible] of free fibers in the nerve trunk.

Dean Lewis found simple longitudinal incision of the thickened epineurium sufficient in most of the cases in which this procedure is indicated. From three to six longitudinal incisions may be needed, depending on the size of the nerve (Fig. [illegible]). Incise the thickened epineurium longitudinally at different points and then [illegible] decompression of the nerve. The fibers may be dissociated when needed. In most cases longitudinal incision of the thickened epineurium will suffice.

NEURORRHAPHY

This consists of suturing divided nerves and may be primary or secondary (Fig. [illegible]).

Primary Neurorrhaphy

A divided nerve should be sutured as promptly as possible. *Fine chromicized* catgut or linen sutures are best suited for the purpose. *End-to-end suture* is the method par excellence; substitute methods are discussed in [illegible].

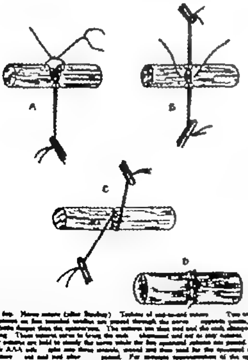


FIG. [illegible]. Nerve suture (after Bunnell). Technic of end-to-end suture. [illegible] (After [illegible].)

Step 1. Make [illegible] incision over the injured nerve.

Step 2. Expose healthy surrounding structures above and below the injured point. Use [illegible] needle to avoid injury to the nerve itself. Remove

the contused parts of the nerve. Approximate only healthy [illegible]. In primary suture [illegible] catgut is used by preference. There are used [illegible] epineural sutures ([illegible]) (Fig. [illegible]).

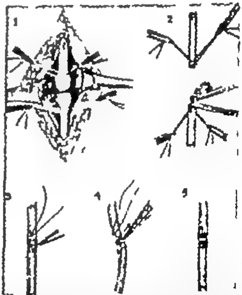
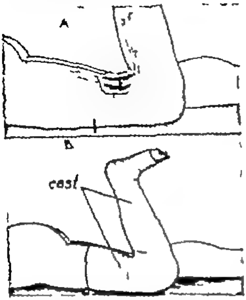


FIG. [illegible]. Nerve suture. The divided nerve [illegible] exposed. [illegible] (After Dean Lewis.)

Step 3. Two [illegible] tension sutures of fine linen are introduced; they avoid dead spaces which when not guarded against will permit [illegible] blood clot to form which will interfere with primary union. Approximation without strangulation of the nerve-ends should be aimed at.

Step 4. Close the superimposed structures.

Comment. Place the limb in such position as to relax the sutured nerve ends. A cast to the limb will act adequately (median or ulnar nerve fixation about 6 weeks, sciatic nerve about [illegible] months).



[illegible] Nerve suture. [illegible]

Secondary Neurorrhaphy

The operation varies in technical details depending upon the pathologic conditions present. Neuromas are usually present.

Step 1. Prepare as above. Be certain that the exposed nerve segments are not rotated during the dissection or the suture of the nerve (Bunnell).

Step 2. Resect the neuroma or scar with [illegible] sharp scalpel. Blunt instruments crush the nerve-ends. Healthy nerve fibers should be seen protruding from the cut ends (Fig. [illegible]). Mobilize the nerve-ends to secure approximation without tension. This should be aided by flexion of the corresponding limb (Fig. [illegible]).

Step 3. Suturing is accomplished as in the previous procedure (vide supra). All manipulations must be gentle.

Step 4. Surround the sutured area, whenever possible, with healthy tissue. Kirschner advises pedunculated muscle flaps from the vicinity; free fat transplants may be used.

Step 5. Close the superimposed structures. Relax. Cast.

POSITIONS AFFORDING MAXIMUM RELAXATION OF INDIVIDUAL NERVE TRUNKS

Median Nerve. Place upper arm close to chest, flex elbow and wrist.

Musculo-spiral Nerve. Place upper arm close to chest, flex elbow fully; dorsiflex wrist.

Ulnar Nerve. If nerve is left behind the internal epicondyle—place upper arm close to chest, extend elbow, flex wrist.

Ulnar Nerve. If nerve is displaced in front of the epicondyle, place upper arm close to chest, completely flex elbow and wrist.

Brachial Plexus. Approximate head to shoulder, elevate arm or place it close to the chest.

Sciatic Nerve and Its Main Divisions. Hyperextend hip, completely flex knee.

Comment. Babcock estimates that the following lengths of gap may be overcome by changes in the position of the different joints. Flexion of the wrist alone will overcome [illegible] gap of 4 cm. in the median and ulnar nerves. Flexion of the elbow, [illegible] gap of 5 cm. in the musculospiral or median nerves. Acute flexion of the knee will overcome [illegible] gap of 8 cm. in the sciatic or popliteal nerves, dorsiflexion of the foot, 4 cm. in the anterior tibial nerve. Extension of the elbow adds [illegible] to [illegible] cm. to the ulnar nerve, hyperextension of the thigh [illegible] cm. to the sciatic nerve, eversion and adduction of the foot, 4 cm. to the posterior tibial nerve. Babcock also found that abduction of the shoulder alone gives sufficient slack to enable one to overcome [illegible] gap of 7 cm. in the musculospiral nerve and somewhat shorter gaps in other branches of the brachial plexus. Rotation of the head to the opposite side gives [illegible] to [illegible] cm. additional slack in cords of the brachial plexus. This may be increased by raising the shoulder on the side of the operation.

Additional lengths may be gained in case of the musculo-spiral nerve by dissecting the nerve free and changing its course to the anterior surface of the arm beneath the muscles. The ulnar nerve may be dissected out of its groove and placed anteriorly. Increased length being then given by flexion of the elbow joint. Additional lengths may be gained in cases of the median nerve by dissecting it from its deep position, placing it more superficial and then flexing the wrist and elbow.

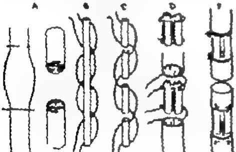
NERVE ANASTOMOSIS

Nerve Implantation

It has been shown that spontaneous regeneration of [illegible] nerve may occur across [illegible] gap without artificial intervention provided the distance to be bridged is not too great (1½ inch). So-called autogenic nerve transplants (Huber) are often of use. A cutaneous nerve is usually employed into strands to accomplish the desired end

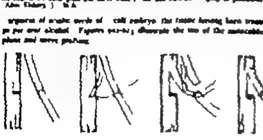
internal cutaneous, radial (superficial branch), external cutaneous in the upper limb). Auto and homotransplants of nerves may be resorted to.

Nageotte [illegible] method of nerve transplantation while decidedly championed by some is energetically opposed by others. It consists of bridging the defect with



[illegible] The cable graft. [illegible]

segments of sciatic nerve of [illegible] calf embryo, the tissue having been treated with 50 per cent alcohol. Figures [illegible] illustrate the use of the autogenous transplant and nerve grafting.



B C

Fig. [illegible] Diagrammatic illustration of partial nerve anastomosis. [illegible]

It has been shown experimentally and clinically by previous authors that by implanting the central end of [illegible] motor nerve into [illegible] denervated muscle, motor endplates will be formed and motor function will be restored. This can be done when the nerve branch is large enough so that an adequate motor supply may be established.

METHOD OF NERVE IMPLANTATION

Step [illegible]. Prepare the central end of the nerve that is to be implanted.

Step 2. Place two epineural sutures at opposite points [illegible] mm. from the end of the nerve.

Step 3. Make [illegible] longitudinal incision in the muscle at [illegible] point most suited for the implantation, considering the movements of that muscle during function.

Step 4. Obtain complete hemostasis.

Step 5. Pass both ends of the epineural sutures in the muscle, at the same time pointing the end of the nerve downward in the direction of the muscle fibers.

Step 6. Close the muscular incision.

Step 7. Place two extra epineural sutures in such a way as to prevent nerve expulsion.

Anastomosis Between the Facial and Spinal Accessory Nerve for Facial Paralysis

(See Nerve Anastomosis for Facial Paralysis, Chapter [illegible], p. [illegible].)

Duchenne-Erb Paralysis—Obstetrical Palsy

This type of paralysis is usually attributed to an injury such as tearing or stretching or pressure on the fifth and sixth cervical nerves, during childbirth. The muscles affected are the deltoid, spinati, biceps, brachialis anticus, supinator longus and brevis and the teres minor. This results in loss of the power of abduction of the arm, inability of flexion at the elbow, the forearm is pronated, and the arm is in [illegible] position of internal rotation. Sensation in the limb is only slightly involved. Turner Thomas states that during childbirth, pressure on the front of the shoulder resulting in [illegible] bending down of the acromion process and [illegible] posterior subluxation of the head of the humerus is the cause of most cases of Duchenne-Erb paralysis.

Reduction of the subluxation is relatively simple soon after birth, but becomes difficult later on.

If injury to the brachial plexus is considered to be the cause of the paralysis, several months of electrical treatment, massage, etc. may be tried. However if no improvement occurs, and if the reaction of degeneration appears in the nerve, operation is desirable.

There are two types of surgical procedure which may be performed:

( ) Nerve anastomosis.

( ) Muscle transplantation.

Operations On the Brachial Plexus

Injuries of the brachial plexus may either be infra- or supra-clavicular. The extent of the injury should be determined by painstaking neurological examination. The degree of injury may be from [illegible] simple stretching of one of the nerves to complete rupture of the plexus (Fig. [illegible]).

(a) Where the Whole Plexus is Paralyzed.—All the arm and hand are involved. The scalenus anticus and

scapus. Occasionally the pectoralis major, the supra- and infraspinatus remain unaffected. The site of the lesion may be traced by the loss of sensation and extent of the paralysis.

(b) Where the Inner Cord is Paralyzed.—Paralysis of the muscles supplied by the ulnar nerve and of the intrinsic muscles of the hand will be observed.

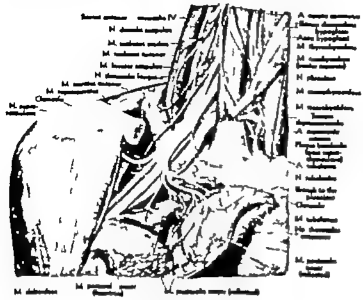


Fig. 64.

(c) Upper Arm Paralysis (Erb-Duchenne Type).—This usually results from injury of the fifth cervical anterior or primary division or a combination of the fifth and sixth. The paralysis affects the deltoid, biceps, supra- and infraspinatus, brachialis anticus and the supinators.

(d) Lower Arm Paralysis.—Here the lesion involves the first dorsal anterior primary division and affects all of the intrinsic muscles of the hand.

TREATMENT

No definite rules can be given. Many patients recover or greatly improve under rest, massage and electrical stimulation. Any lesion causing paralysis in the infraclavicular cases should be subjected to prompt surgical treatment. Also

where a complete supraclavicular lesion follows direct injury early exploration is strongly indicated.

Step 1. Make an incision extending from the junction of the lower and middle thirds of the sternocleidomastoid muscle to the outer end of the clavicle. Whenever necessary divide the clavicle.

Step 2. Endeavor to identify the nerves; this is sometimes very difficult. Suture of roots may be impossible owing to the proximity of the intervertebral foramina.

Step 3. Attempt end-to-end suture and if that is impossible, resort to nerve-anastomosis.

Step 4. Immobilize the arm in a position free from strain.

SECOND METHOD—NERVE ANASTOMOSIS (ROBERT KENNEDY'S OPERATION)

Step 1. The patient is placed on his back with a support under his shoulders. Rotate the head and face toward the opposite side.

Step 2. Make an incision beginning at the junction of the middle and lower thirds of the outer margin of the sternomastoid, passing outward and downward and ending at the junction of the outer and middle thirds of the clavicle. The fascia between the trapezius and sternomastoid is then divided.

Step 3. Expose the omohyoid, and then above it, the scalenus anticus. The nerve trunks are seen coming out from beneath it. Follow them outward to the junction of the fifth and sixth nerves and separate them from adhesions.

Step 4. The isolated nerve usually consists of scar tissue. Sever the fifth and sixth nerves above the affected area. Then the three peripheral divisions of the nerve are severed beyond the damaged portion.

Fine chromicized catgut is used to suture the three peripheral divisions to the two central stumps. To relieve tension before suturing elevate the shoulder and bend the head to the side of the operation. Place the muscle or fascia over the nerve suture line.

Step 5. Close the wound and drain. Keep the shoulder elevated and the head inclined toward the operative side by means of a suitable apparatus, and prevent motion of the head on the shoulders.

Remove the final drainage after two weeks. Kennedy advises no special after-treatment. Some surgeons institute electrical stimulation and massage. Purves and Low advise using electrical tests previous to excising parts of the nerve to prevent destruction of healthy nerve tissue.

MUSCLE TRANSPLANTATION ([illegible] OPERATION)

This operation is done in two stages.

Stage 1. Restoring *Flexion of Elbow.*

Step 1. An incision is made from the center of the posterior aspect of the upper arm downward and forward, for about five inches, toward the anterior aspect of the elbow following the musculospiral groove. The musculospiral nerve is exposed and drawn aside.

Step 2. Separate a wide strip of the external portion of the triceps muscle from its tendon, leaving its upper portion attached to the rest of the muscle. Using

the same incision, expose the anterior end of the biceps muscle. Make a tunnel through the muscle from behind forward, two inches above the elbow.

Step 3. Relieve tension by flexing the elbow. Pull the end of the triceps flap *through the tunnel in the biceps and suture it there.*

Close the wound and apply dressings. Immobilize the elbow in flexion. Allow no movements for four weeks.

Stage 2. Restoring Abduction of the Shoulder.

Step 1. Make an incision laterally beginning about an inch below the center of the clavicle, to the tip of the acromion and then extending it downward for several inches. Detach the clavicular part of the pectoralis major muscle from the rest of the muscle and divide its insertion into the humerus. This forms a muscular flap attached to the clavicle. The insertion of the trapezius muscle into the clavicle is divided. Then the corresponding portion of the muscle is separated from the rest of the trapezius by splitting it in the course of the fibers. This forms a second muscular flap.

Step 2. The free end of the pectoralis major flap is brought upwards over the acromion process and fixed into the deltoid muscle. To avoid slipping, suture several of the pectoral fibers to the tip of the acromion. Suture the end of the trapezius flap to the lateral part of the pectoral flap. Close the wound and apply dressings. Immobilize the arm in abduction without motion for four weeks, and then slowly begin exercises.

Tubulization

This consists of encouraging nerve regeneration to progress between the ends of a nerve, along a tube, along which the neurofibrillae may grow. Materials used for this are fascia and veins turned inside out to avoid the regenerating endothelium from interfering with nerve regeneration and function. The usefulness of the method is still sub judice.

OPERATIONS FOR CAUSALGIA

Injection, Freezing, Crushing, Chordotomy

Weir Mitchell studied causalgia during the Civil War. He pointed out that nerve pains may be relieved by injecting the nerve above the site of injury with alcohol (70 to 95 per cent). The injection of 1 to 3 cc. alcohol blocks afferent impulses for months. Some surgeons prefer the injection of absolute alcohol (Trotter). Lower strengths (Figs. 617-618-619-620) abolish sensory conduction and affect the motor paths only slightly (this is important in the treatment of mixed nerves).

For temporary interruption of pain in a given nerve the Trendelenburg-Perthes method for freezing the nerve is of advantage. Ethyl chloride—[illegible]—is used in this method. Kutscher advocated exposing the nerve and placing it between two cubes of carbon dioxide snow (80°) from [illegible] to 10 minutes.

Nerve crushing with an angiotribe is used by some.

Foerster's operation for the relief of pain consists of interrupting nerve conduction at the spinal cord (laminectomy; exposure and division of the posterior roots of the spinal cord).

SPASTICITY (FOERSTER'S OPERATION)

According to Foerster, "If we admit that spasticity or spastic muscular contractures are reflex disturbances, unrestrained by cortical impulses, one way, but not the only way of controlling them, is to remove at least one link in the chain of the reflex arc. Naturally the motor portion of the arc, the anterior horn, the roots, or the peripheral nerves cannot be broken, otherwise the limb would be hopelessly paralyzed; for the same reason the sensory nerves, many of which are mixed nerves, must be left intact, so that by a process of exclusion there remain the sensory roots." (See Fig. 6[illegible] A, page [illegible].)

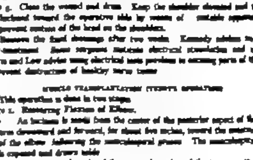


Fig. 6[illegible]. Injection of median and ulnar nerves with 80 per cent of alcohol (causalgia). (After Dean Lewis.)

This operation is indicated in stubborn cases of radiculitis and is often performed in two stages. First, a laminectomy is performed and several days later the dura is opened and the work completed. Ample exposure of the posterior surface of the cord is necessary so that the posterior roots may be recognized. Blood should be removed by irrigation with warm salt solution as sponges are likely to injure the delicate nerves. The number of nerve roots removed varies.

Hoffmann's Method of Performing Foerster's Operation

Step 1. Make an incision over the spinous processes of the vertebrae to be resected and free the muscle-structures from the spinous processes and laminae on both sides, by blunt dissection. Control hemorrhage by means of gauze pressure.

Step 2. With an osteotome held in a horizontal position, divide the laminae on either side.

Step 3. Make a transverse incision in the interspinous ligament either above or below the selected vertebrae in accordance with the direction the bone flap is to be turned back. Incise any remaining connecting structures either upward or downward. The dura is now exposed, but if more ample exposure is desired, pieces of bone are removed with a rongeur forceps.

Step 4. Make an incision in the dura longitudinally; divide the posterior spinal roots involved.
Step 5. The edges of the dural wound are united by continuous suture.
Step 6. The bone flap is replaced, the muscles and fascia over the spinous processes are sutured and the skin incision closed.

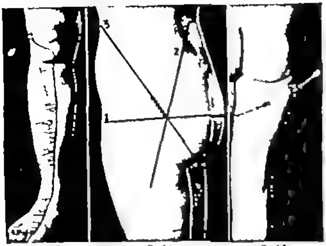


Fig. 606. Fig. 607. Fig. 608.

Fig. 606. [illegible] of the nerve [illegible] for purposes of blocking the external popliteal nerve. Ascertain the position of the fibula by palpating the point where it crosses the head of the fibula. [illegible] area shows [illegible] extent of anesthesia [illegible] from blocking this nerve.
Fig. 607. Blocking of the sciatic nerve. Line [illegible] between the prominent point of the greater trochanter of the femur [illegible] the posterior superior spine of the ilium [illegible] to the tuber ischii [illegible] the [illegible] line [illegible] to the gluteal [illegible] the [illegible] of the [illegible]. The [illegible] the sciatic nerve.
Fig. 608. Posterior view.

Stoffel Operation

When a certain set of affected muscles is overexcited, the nerve supply to the particular group is surgically exposed, its identity ascertained by electrical stimulation and the nerve bundle supplying the given muscular group is either divided or a portion of it resected (several cm.) (Fig. 609. See also p. [illegible], Rhizotomy.)

NERVE STRETCHING

This is indicated in cases of sciatica brought about by exposure to cold and dampness and in which the pain radiates along the nerve route.

Sciatic Nerve

Step 1. Place the patient in the prone position. From a point midway between the tuber ischii and the great trochanter make a longitudinal incision about 4 inches long, beginning at the gluteal fold and extending downward.
Step 2. Incise the fascia. Retract the gluteus maximus muscle upward. Retract the hamstring muscles outward after bending the knee to relax them.

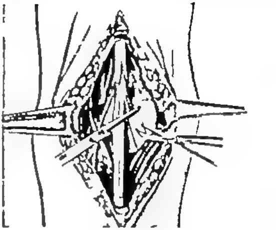


Fig. 609. Stoffel's operation for relieving spasticity. Individual nerve bundles are exposed as shown in the illustration and divided, thus cutting off the innervation of certain muscles.

Step 3. Hook up the nerve which is now exposed with the finger and retract upward and downward with a strong, steady pull.
Step 4. Replace the nerve. Close the wound.

Exposure of Internal Popliteal Nerve (Tibial Nerve)

Step 1. Make an incision over the space between the two heads of the gastrocnemius muscle extending downward 2½ inches from the middle of the popliteal space.
Step 2. Draw back the short saphenous nerve and vein and incise the deep fascia.
Step 3. Bend the knee for purposes of relaxation and separate the two heads of the gastrocnemius muscle. The short saphenous vein upon its return to the popliteal space goes directly to the popliteal vessels over which the nerve lies.

Step 4. Stretch the nerve by hooking it over the finger and applying traction upward and downward.

Exposure of External Popliteal Nerve (Peroneal)

A method of exposing this nerve is described by Treves as follows.
Anatomy. The external popliteal or peroneal nerve follows the outer side of the popliteal space lying close to the biceps. Passing over the outer head of the gastrocnemius, between it and the biceps, the nerve reaches the neck of the fibula, and there it lies beneath the fibers of the peroneus longus muscle. The nerve may be easily felt, when the knee is a little flexed, as a [illegible] cord, lying just behind the biceps, as it nears the head of the fibula.
Operation. The patient lies upon the sound side, with sufficient turning to the prone position to well expose the outer aspect of the knee. The knee-joint is extended. An incision, one inch and a half in length, is made parallel with and immediately posterior to the tendon of the biceps. The cut should be so placed that its

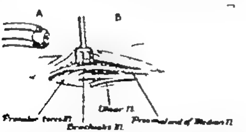


Fig. 610. [illegible] the median nerve [illegible] for pronator teres, flexor carpi radialis and palmaris longus [illegible] for the flexor sublimis digitorum [illegible] for the flexor profundus digitorum and flexor longus pollicis [illegible] the thenar muscles and first and second lumbricales. [illegible]

upper half is in relation with the tendon while its lower half is over the fibula. The skin and deep fascia having been divided, the biceps tendon is exposed. The knee should now be a little flexed and the nerve sought, close to the point at which the tendon reaches the head of the fibula. A narrow and unduly prominent fibrous band has been mistaken for the biceps tendon.

Facial Nerve

Satisfactory results have followed the stretching of this nerve in cases of spasmodic tic. Kocher recommends this procedure highly. The operation for exposing this nerve is described elsewhere.

Exposure of Musculospiral (Radial) Nerve

Injury or pressure caused by a fractured humerus are the chief reasons for exposing and treating this nerve (see also Fracture of Humerus).

METHOD OF EXPOSING NERVE IN LOWER PART OF ARM

Step 1. Make an oblique incision about 3 inches long between the supinator longus and the brachialis anticus muscle. The incision is confined to the lower third of the arm.

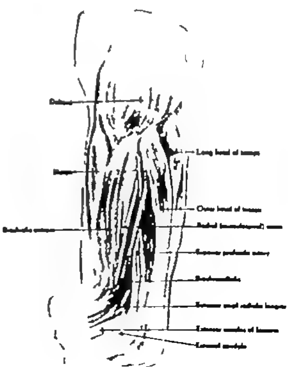


Fig. 611. The radial (musculospiral) nerve and outer side of arm.

Step 2. Incise the deep fascia; expose the nerve which lies between the supinator longus and the brachialis anticus, by separating these muscles (Fig. 611).
Step 3. Pursue the nerve in an upward direction to the point of injury; avoid

puncturing its accompanying artery. If exposure of the nerve cannot be obtained below the site of injury expose it above.

EXPOSURE OF THE NERVE IN THE UPPER OR MIDDLE PART OF ARM

An incision is made between the long head and the external head of the triceps beginning a little below the posterior axillary fold and extending downward. By blunt dissection divide the two heads of the muscle down to the bone, thus exposing the nerve and profunda artery.

Schwarz and Kuss recommend the following procedure for exposing this nerve:[1]

Step 1. Place the patient in the dorsal position: hold the arm vertical but incline it slightly toward the center; hold the forearm at right angles to the arm resting the hand on the chest inside the opposite axilla.

Step 2. Make a skin incision along an imaginary line drawn from the tip of the olecranon exactly in the midline of the posterior surface of the arm to the prominent posterior border of the deltoid. Begin the incision about 4 finger breadths below the tip of the olecranon and extend it downward to the nerve lesion—usually from 12 to 18 cm.

Step 3. Incise the subcutaneous tissue exposing the deep fascia.

Step 4. Retract the borders of the aponeurotic wound after incising the brachial aponeurosis for the entire length of the wound. The V-shaped tendon of the long triceps can be seen on the ulnar side of the midline in the distal portion of the wound.

Step 5. Divide the fibrous tissues along the radial border of the V-shaped tendon between it and the tendon of the external head of the triceps. This incision reveals a muscular space between the external head of the triceps on the radial side and the long head of the triceps on the ulnar side. The incision of the triceps, if kept strictly to the midline, presents a yellowish-white fascia, varying in thickness and consistency. The musculospiral nerve and its accompanying vessels are bound to the humerus by this fascia.

Step 6. Incise the fascia exposing the nerve from the axilla to the point where it enters the external intermuscular septum.

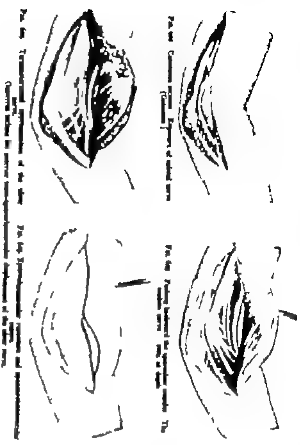
In some cases the terminals of the divided nerve cannot be found. For instance, after an external condyle has been fractured, there may be a quantity of callus which presses on the nerve rendering the restoration of conduction out of the question. Tendon transplantation is then resorted to.

ANTERIOR TRANS-EPITROCHLEO MUSCULAR DISPLACEMENT OF THE CUBITAL NERVE (GUTIERREZ TECHNIC)[2]

In traumatisms about the region of the elbow the cubital nerve is frequently injured resulting in late paralyses which often call for subsequent operations. Gutierrez has evolved a method of transposing the nerve which he claims is free from certain disadvantages observed in other current procedures for the transposition of the nerve.

Step 1. The arm is put in abduction and the forearm fixed in external rotation. Make a curved incision about [illegible] to 10 cm. over the epitrochleo-olecranon canal: about 10 to 12 cm. of the incision is on the arm (Fig. [illegible]).

[1] Revue de Chir., No. [illegible], 1920.
[2] Revist. de Cirug. Buenos Aires. No. 3, Aug. 1925.



Step 2. Expose the lower part of the epitrochlea. Some fibers of the internal cutaneous brachial nerve and the cubital vein are exposed. The continuation of the cubital nerve is exposed throughout all the length of the incision from one extremity to the other. In its inferior extremity it is necessary to section the antibrachial aponeurosis and the anterior cubital muscle for some 8 cm., taking care not to injure nerve fibers in the lower segment (Fig. 623).

Step 3. The epitrochlea is mobilized in its most superficial part and the insertions of the epitrochlear mass in the humerus sectioned with chisel and mallet.

Step 4. The epitrochlea and its inserted muscles are lifted partly from the deep muscle-plane and pushed backward. In the depth the median nerve is seen reposing on the internal part of the anterior brachial muscle. In its lower segment it traverses the round pronator muscle.

Step 5. The cubital nerve is easily isolated, especially in its superior part, and is transplanted to the anterior muscle-plane. In order that the nerve should not be displaced posteriorly above the epitrochlea, a couple of catgut sutures are passed through the deeper part of the mobilized muscles and the superficial flexor muscle outside the nerve (Fig. 624).

Step 6. The fragment of mobilized epitrochlea is replaced in position and fixed and the wound closed (Fig. 625).

Note. If the loss of cubital nerve is so great that terminoterminal anastomosis of its ends is impossible the premuscle situation of the median nerve allows an easy implantation of the cubital nerve.

METHOD OF EXPOSING THE POSTERIOR INTEROSSEOUS BRANCH OF THE RADIAL NERVE (GUTIERREZ TECHNIC)

Step 1. *Separate the arm about 45 degrees from the thorax.* The forearm in about 45 degrees of flexion with the arm and resting upon a table by its cubital edge.

Step 2. Make a vertical incision extending from about a couple of finger widths below the epicondyle to about one or two finger widths above the styloid apophysis (Fig. 626). Incise the skin and subjacent tissues exposing some veins and nerve-fibers. The aponeurosis is cut about the lower half of the incision, thus exposing the large abductor and the short extensor muscles of the wrist. The plane of separation between the second external radial and the common extensor of the fingers is exposed above the superior border of the large abductor. The short supinator muscle is seen above the large abductor of the wrist (Fig. 627).

Step 3. The posterior branch of the radial nerve runs at some three finger widths beneath the epicondyle, deeply situated and running between the short supinator, the large abductor and short and large extensors of the wrist. By sectioning the short supinator superficially the intramuscular part of the radial nerve is exposed. *The articulation of the elbow in its humeroradial segment,* can, if necessary, be exposed by prolonging the incision in its upper part to a little above the epicondyle and by separating the muscle (Fig. 628).

Revist. de Cirug. Buenos Aires, Aug. 1925.

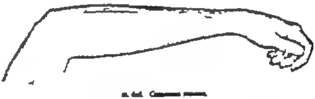


Fig. 626. Cutaneous incision.

Fig. 627. Exposure of deeper structures.

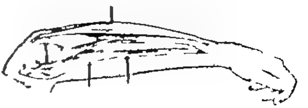


Fig. 628. Cutaneous incision of exposure of the posterior branch of the radial nerve.

CHAPTER 30

SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM

Anatomic Considerations. The nerve structures of the ganglion-chain system are generally described as "sympathetic" while the nerve elements of the visceral, cranial and pelvic region are referred to as "parasympathetic" or "autonomic."

EXCISION OF THE SYMPATHETIC NERVES

PERIARTERIAL SYMPATHECTOMY

René Leriche enriched the literature with his valuable contributions on surgery of the sympathetic nervous system.

Leriche Technic

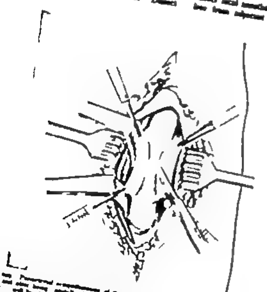


Fig. Periarterial sympathectomy of the femoral artery.

Step 5. In order to clear the posterior wall of the vessel, push the artery aside

the purpose of obliterating the nerve plexus contained in it as well as for the purpose of disconnecting it from the nerves of origin and peripheral plexuses, the procedure is called periarterial sympathectomy.

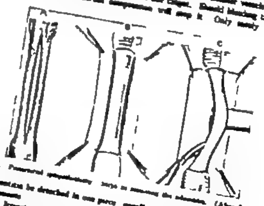


Fig. Periarterial sympathectomy. Steps in removing the adventitia. (After Leriche.)

adventitia be detached in one piece; usually it is lacerated and removed in fragments.

Step 6. Irrigate the wound with warm normal saline solution to eliminate the debris.

CERVICOTHORACIC SYMPATHECTOMY*

Step 1. Make a skin incision parallel to the posterior border of the sternomastoid muscle and extending from the tip of the mastoid process to the lower border of the clavicle.

Step 2. Divide the external jugular vein between ligatures.

Step 3. Liberate the carotid jugular-vagus bundle.

of the neurovascular sheath as it may possibly be caught up by the retractor. It is smaller than the vagus nerve, rather flat and its diameter is unequal. Do not confuse the sympathetic with the pneumogastric, the descending branch of the hypoglossal and the phrenic nerves. The phrenic nerve courses over the scalenus muscle and is usually far lateral to the position of the sympathetic. Having once successfully identified the cervical sympathetic chain, the surgeon experiences no doubt in subsequent operations. At first, however, it is well to identify absolutely the nerve before cutting it by following it up to the fusiform superior cervical ganglion.

Step 4. After positive identification, liberate as much of the trunk as is necessary for the completion of the operation. If the entire cervical chain and stellate ganglion are to be removed, free the superior cervical ganglion and dissect downward, using the freed part of the chain for traction. After cutting its lateral branches, either sever or evulse the superior ganglion from its cranial attachments. The cervical chain may appear in front of or behind or may surround the inferior thyroid artery. Continuing downward, the inferior cervical ganglion is usually found against the neck and head of the first rib between the scalenus anticus and longus colli muscles and just above the pleura. It is in intimate contact with the vertebral artery which is usually enlaced in a network of sympathetic branches.

Step 5. Carefully free the vertebral artery, then retract downward and outward the thyroid axis, vertebral and subclavian vessels, the scalenus anticus muscle and the pleura and the sternomastoid muscle and the carotid sheath with its contents. Divide the lateral branches of this ganglion and follow the sympathetic trunk upward to the first thoracic ganglion. These two ganglions lie very close together and may appear almost fused. On occasion a small ganglion appears in what Jonnesco has termed the "Scaleno-pleuro-vertebral wall" which rests posteriorly against the transverse process of the seventh cervical vertebra and the first and second ribs. It is important, while dissecting, not to break the cervical chain which acts as a durable guide to the inferior cervical and first thoracic ganglion which often are in their cervical position. Besides, it acts as a tractor to deliver these ganglia from the thorax.

Step 6. Hemostasis. Close the wound with fine silk; this is also employed for ligatures.

Comment. General anesthesia, local anesthesia or a combination of both may be used. The principal dangers of the procedure are injuries to the following structures: vertebral artery and vein, the first intercostal artery or its cervical branch, the subclavian vessels, the pleura, the retroclavicular venous-plexus and the thoracic duct on the left side.

To remove only the superior cervical ganglion many use an incision anterior to the sternocleidomastoid muscle, opposite the bifurcation of the common carotid artery. This incision may be transverse. The sternomastoid is displaced with a retractor outward, the neurovascular bundle toward the median, the connecting branches of the ganglion are divided and the ganglion is severed or evulsed from its attachments.

[illegible] in the cervical region, ligation of the vertebral artery [illegible], and consult Figs. [illegible] and [illegible].

In cervicothoracic sympathectomy it is not difficult to lift the trachea and esophagus forward and divide the sympathetic nerve on the opposite side.

RAMICOTOMY

(See also p. 342, Stoffel operation)

Ramicotomy was introduced in 1924 by Hunter and Royle for treating spastic paralysis. Gask employed it for the relief of gastric pains (tabetic cases) and René Leriche resorted to its use in painful conditions of the extremities. According to Leriche, ramicotomy may be performed in the (a) cervical, (b) dorsal, (c) lumbar or (d) sacral region.

CERVICAL RAMICOTOMY

The superior branches in the cervical region may be exposed by making an incision along the posterior margin of the sternomastoid muscle. Care should be taken not to go beyond the prominence of the external jugular vein, which indicates the direction taken by the spinal accessory nerve.

If it is desired to expose the inferior nerve, the following technic has proved successful.

Step 1. Make an oblique incision 6 cm. long between the two bellies of the sternocleidomastoid and in the direction of its fibers, terminating on the superior margin of the clavicle. Retract the tissues.

Step 2. The plane of the intermediate aponeurosis is uninterrupted and tubing the sternocleidomastoid bed. The omohyoid muscle is seen beneath the sheath of the aponeurosis in its lower part protruding below it. Make an incision beginning at the omohyoid muscle. Divide the muscle a short distance from the intersection of its fibers. If a small artery is divided on the upper surface, ligate it. Completely divide the aponeurosis. The incision should extend anteriorly to the neuro-vascular bundle in the neck; posteriorly it should extend to the scalenus muscle and the phrenic nerve and below to the subclavian artery. If the incision is directed toward the thorax, the thyroid artery, the vertebral artery and the sympathetic nerve will be exposed.

Step 3. Expose the prevertebral space. Dissect the adipose tissue from it, thus exposing anteriorly the internal jugular vein, the common carotid artery and the pneumogastric nerve which are drawn to one side with a blunt retractor. Posteriorly, the phrenic nerve crosses the surface of the scalenus. Direct the point of the instrument by visual guidance. Small tampons moistened in normal salt solution and a blunt instrument like a Kocher director facilitate the manipulations. One retractor pulls the structures gently outward and the other inward.

Step 4. Isolate the inferior thyroid artery. The vessel arises in a curve; it is well exposed from the subclavian artery to the thyroid. The anterior branch of the sympathetic and the loop of Vieussens are exposed. The latter does not always appear where it is expected. Insert a thread under these branches and retract them. Draw the thyroid artery outward by means of a retractor.

Step 5. Expose the vertebral artery which lies deeper and farther back than the thyroid (see also ligation of vertebral artery p. 898). It may be located, unless the patient is very fat, by pressing a damp sponge on the deep layer

Step 6. Exposure of the ganglion and its branches is accomplished by dissecting the deep tissues and connecting branches under visual guidance. Bleeding rarely follows. The subclavian artery is barely visible.

If complete section of the second cervical and first dorsal is aimed at, they will be found coursing from above downward.

CERVICAL RAMISECTION*

In this operation only the rami communicantes are divided. Only in approaching the first thoracic nerve does the sympathetic trunk come into the operative field. The first thoracic nerve itself usually has both a white and gray ramus like the rami above. [illegible] preganglionic fibers. As a rule, the sympathetic rami join the nerve roots of the brachial plexus after they leave the intervertebral foramina, although sometimes they enter the nerve roots within the foramina. The second area for the nerve roots of the brachial plexus is between the scalenus anterior and scalenus medius muscles, according to [illegible]. However, it is much more common to find the fifth and sixth roots penetrating the scalenus anterior; many times these roots appear in front of the muscle. A bundle of muscle fibers often divides the seventh and eighth nerves. The eighth cervical and first thoracic nerves usually appear back of the scalenus anterior. The operation is simple if the nerves form a regular plexus; the emergence of each nerve root separately through the scalenus anterior renders the procedure much more complicated. (Fig. 671.)

Step 1. Place the patient on his back, turn his chin away from the site of operation and put a pillow under his shoulders. Make an incision from the clavicular insertion of the sternomastoid backward and upward across the posterior triangle. It may be necessary in some instances to make a second small incision, directing it upward along the posterior border of the sternomastoid so as to be sure of reaching the fibers connecting the fifth and sixth nerves.

Step 2. Divide the platysma and secure the external jugular vein in the line of the original incision. Divide the front layer of cervical fascia and by means of blunt dissection expose the deep layer of fascia which covers the brachial plexus and the scalenus muscle; the superficial cervical artery is often encountered between the two layers; the transverse colli artery often appears in a deeper plane between the seventh and eighth nerve-roots; ligate and divide this artery. Retract the omohyoid muscle downward.

Step 3. Identify the phrenic nerve in the upper part of the plexus. Expose the nerve-roots to the intervertebral foramina. Draw the subclavian artery forward exposing the eighth cervical and first thoracic nerve. The rami communicantes are difficult to identify; those connected with the fifth and sixth nerves may traverse the scalenus anterior in front or they may penetrate the muscle itself. There may be two or more branches, making it necessary to exercise care to see that all of the nerve roots and their anterior connections are separated up to the intervertebral foramina. In some cases gray rami are joined to the nerve roots on their antero-inferior aspects. Medullated muscular branches appearing on the front surface of the nerve

* After Royle.

roots may be confused with the sympathetic; if there is any doubt concerning their identity they should be preserved. If the phrenic nerve is connected to the fifth cervical nerve, retract it. Great difficulty is likely to be encountered with the eighth cervical and first thoracic nerves. The latter should be looked for across the neck of the first rib; the nerve trunk may be traced into the thorax. The cervical sympathetic trunk is usually located

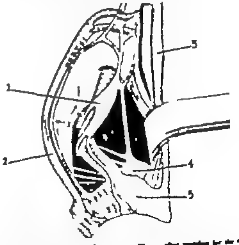


Fig. 671. [illegible]

behind the subclavian artery thus facilitating the identification of the communicating ramus to the eighth nerve. From here on this trunk tends to follow a medial course into the neck, but very [illegible] be found on the eighth nerve-root. Avoid, if possible, the gray ramus of the first thoracic nerve which is found on its superior surface parallel to the white ramus. Use a small aneurysm hook to divide the rami in this operation.

Step 4. Close the wound by approximating the edges of the platysma and suturing the skin. Drainage is unnecessary.

DORSAL RAMICOTOMY

Ramicotomy is a rather difficult task to accomplish. Gask recommends approaching the dorsal nerve in the deepest part of the intercostal space which is made larger by resecting the corresponding transverse process. The connecting branch is approached where it ends on the intercostal branch of the dorsal nerve

Step. Make a vertical incision starting 4 cm. above the highest of the intervertebral spaces to be reached and extending two finger breadths from the line of the spines.

Step. Detach the vertical muscles from the processes. [illegible] necessary about 3 cm. outward from the costal tubercle.

Step 3. Resect the transverse processes and search for the nerve in the intercostal space. Retraction of the soft parts with a blunt tenaculum is helpful. If the nerve cannot be seen, across the muscle fibers perpendicularly. The subcutaneous fascia [illegible] be seen to form [illegible] bed for the nerve.

Fig. [illegible]. Dorsal Ramisectomy. [illegible] [illegible]

Step. With [illegible] hook, grasp the nerve trunk, drawing [illegible] outward, backward and upward, thus liberating the inferior connecting branches. After locating the branch, leave the intercostal in region where there is no superior connecting branch as sometimes happens. (Fig. 631A.)

LUMBAR RAMICOTOMY

The best method for doing [illegible] unilateral resection is the procedure known as lateral retroperitoneal laparotomy.

Step 1. Make a vertical incision beginning at the front end of the eleventh rib and extending downward to [illegible] cm. above the anterior superior iliac spine, then turn making the incision parallel with the crural arch 3 cm. away from it as far as the margin of the rectus muscle. In cases where the costo-iliac space is extremely narrow it may be advisable to make [illegible] superior transverse incision beginning at the apex of the eleventh rib about 8 to 10 cm. long. The intercostal, iliohypogastric and ilio-inguinal nerves are not divided. The muscles are incised in layers. It is hardly ever necessary to incise the major oblique but the minor oblique and transversalis are cut transversely.

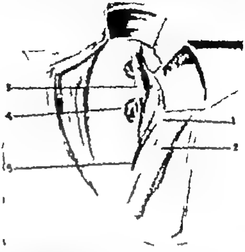


Fig. [illegible]. The second and third lumbar ganglia [illegible] [illegible]

Step 2. Incise the transversalis fascia thus opening the subperitoneal space.

Step 3. Liberate the peritoneum by pushing the intestines inward with [illegible] sponge, thus exposing the psoas and surrounding area as far as the liver vessels and spinal column.

Step 4. With [illegible] large valve retractor, draw the intestine inward toward the midline. With another retractor displace the structures upward and outward exposing the [illegible] vessels, the origin of the vena cava or the aorta (depending on the side involved) and the lateral aspect of the lumbar column (Fig. 632). The sympathetic is found lying on the prominence of the psoas in front of the vertebral column. The lymphatic vessels and

[illegible] are seen to the midline. The [illegible] generally observed [illegible] the third lumbar ganglion [illegible] followed.

Step 5. [illegible] on the upper retractor to expose the second ganglion from which branches emerge and disappear under the arch of the psoas muscle.

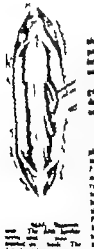


Fig. [illegible]. [illegible]

Step 6. After excising the first four branches expose the fifth by detaching the [illegible] from the deep layer and elevating them. The [illegible] vessels are sometimes difficult to locate but should be searched for on the internal aspect of the common iliac vessels above the hypogastric artery.

Comment. There seems to be [illegible] tendency toward the [illegible] of [illegible] treatment on the divided sympathetic nerves. [illegible] the belief that the [illegible] failures of sympathetic nerve surgery are due to the formation of fresh neuromas.

Ramisectomy is indicated in spastic paralysis, angina pectoris, bronchial asthma, abdominal visceral disturbance and painful conditions in the extremities as well as abnormalities of the vasomotor system.

PRESACRAL NERVE RESECTION

Anatomic Considerations. (Fig. 633) [illegible] The plexus [illegible] [illegible] [illegible] [illegible] [illegible] the presacral nerve of Latarjet and [illegible], the presacral nerve of [illegible], the superior hypogastric plexus of [illegible], is according to [illegible] made up about as follows. Beginning in the plexus situated between the superior and inferior mesenteric arteries, to these nerve-elements are added the communicating nerves of [illegible] and [illegible], also lumbar sympathetic fibers from both sides so that at the level of the inferior mesenteric artery these nerves divide into two distinct bundles— the anterior mesenteric plexus and the superior hypogastric plexus.

According to [illegible], the superior hypogastric plexus [illegible] [illegible] of the inferior mesenteric plexus below the inferior mesenteric artery and includes the part of the plexus that extends from the superior part of the fourth lumbar vertebra to the middle of the first sacral vertebra, where it divides into two terminal plexuses called the right and left inferior hypogastric plexuses.

Important branches to the plexus come from the lumbar sympathetic chains. [illegible] and [illegible] found that branches came from the first and second lumbar ganglia, also from the third and fourth, and that the superior mesenteric plexus [illegible] made up in similar fashion to the splanchnic nerves and consequently these branches are often referred to as the pelvic splanchnic nerves. About one inch below the origin of the inferior mesenteric artery the superior hypogastric plexus begins. The plexus enters the pelvis over the bifurcation of the aorta, crosses the left iliac vein, passes over the sacral promontory and on down over its anterior surface. According to the studies of [illegible], the [illegible] and [illegible], the arrangement of the plexus is quite irregular.

[illegible] [illegible] [illegible] of Surgery [illegible]

[illegible] Generally speaking, the lower end of the superior hypogastric plexus [illegible] at the level of the bifurcation of the common iliac artery [illegible]. It extends from the upper part of the lumbar [illegible] to the middle of the first sacral vertebra. [illegible]

Indications. This procedure [illegible] indicated in cases of dysmenorrhea where there is no organic lesion [illegible]

This operation is recommended by [illegible] and others in cases where there [illegible]

[illegible] Douglas.

This operation may be accomplished by resecting the superior hypogastric plexus alone, or by resecting the inferior mesenteric ganglia, or [illegible] the lumbosacral sympathetic on both sides, or it may be a combination of all the above mentioned procedures. In most cases [illegible] (Fig. 634.)

Dangers of Operation. [illegible]

Results. [illegible]

[illegible]

SURGICAL EXPOSURE OF THE LUMBAR SYMPATHETIC TRUNKS BY MOBILIZATION OF THE ROOT OF THE MESENTERY

Albert Gutierrez points out that in the adult the root of the mesentery [illegible]

Fig. [illegible] (Gutierrez.)

[illegible] Gutierrez' method of mobilization of the root of the mesentery is based on the existence of these [illegible]

Step 1. Place the patient in the Trendelenburg position [illegible]

Step 2. Displace and pack away the intestines to the right. The left surface of the mesentery is thus exposed (Fig. [illegible])

Step 3. [illegible]

Step 4. Grasp the mesentery with [illegible] forceps, pull [illegible] downward and to the right. [illegible]

Fig. [illegible] Following incision of the peritoneum and pulling the mesentery downward [illegible]

[illegible] (Figs. [illegible])

Step 5. [illegible]

Step 6. Close the peritoneum (Fig. [illegible])

LUMBAR SYMPATHETIC RAMISECTION

[illegible] is as follows.

[illegible]

Fig. [illegible] (Gutierrez.)

[illegible]

Step [illegible]

[illegible]

[illegible] should serve as [illegible] guide. The forwardly directed part of the incision should be about one centimeter below the actual crest of the ilium. This enables the attachment of the external oblique muscle to be exposed. The flap of skin and fascia outlined by this incision is reflected forward to expose the attachment of the latissimus dorsi to the lumbodorsal fascia and of the external oblique muscle to the crest of the ilium.

Step 2. The [illegible] is now defined and from this point forward the oblique muscles are freed from the crest of the ilium to within six or eight centimeters of the antero-superior spine of the ilium. In doing this

Fig. 648. Fig. 649.

Fig. 648. Exposure of the right sympathetic [illegible] in the upper part the third portion of the [illegible]

Fig. 649. Exposure of the left sympathetic [illegible] and the beginning of the [illegible]

it [illegible] possible in most subjects to divide the external oblique through [illegible] tendinous fibers close to its insertion and to avoid cutting the actual muscle fibers. This gives [illegible] decided advantage in closing the wound. The internal oblique and transversus abdominis muscles are divided through the muscle fibers close to their attachment. The dissection is then carried upward and the lumbodorsal fascia [illegible] divided at the lateral border of the quadratus lumborum. In doing this [illegible] may be necessary to cut through the fibers of the latissimus dorsi.

Step 3. The abdominal wall is now just to be thrown forward and after dividing the fascia transversalis the hand can be passed in front of the quadratus lumborum and the psoas muscles until the medial border of the psoas [illegible] palpated. Suitable retractors are then placed in position. Care should be taken not to disturb the fascia covering the quadratus lumborum and fascia covering the psoas muscle.

[illegible] very fat subject, however, the approach to the sympathetic trunk may be rendered more easy by leaving the transversalis fascia intact except at the medial border of the psoas muscle where [illegible] must be [illegible] to reach

the sympathetic trunk. The [illegible] sympathetic trunk can often definitely be palpated where it lies at the medial border of the psoas muscle before it can be seen. The psoas itself sometimes constitutes [illegible] difficulty in the adult subject by obscuring the trunk from view and [illegible] suitable retractor is necessary to flatten the muscle. In children and poorly developed subjects this difficulty is not great.

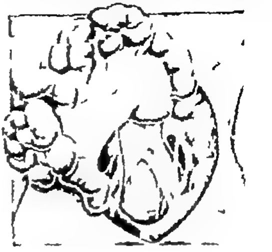


Fig. 650. View of the retroperitoneal [illegible] exposed by means of [illegible] abdominal [illegible]

[illegible] The [illegible] sympathetic trunk will be found lying on the bodies of the lumbar vertebrae near the medial border of the psoas muscle. The abdominal sympathetic trunk on the left side is easy to define, if the medial border of the psoas is sought. In this situation [illegible] thin layer of connective tissue passes from the psoas muscles across the sympathetic trunk, and [illegible] to the region of the psoas on the opposite side. This is easily [illegible] with blunt dissection and the sympathetic trunk comes into view. On the right side the trunk lies under the lateral margin of the inferior vena cava and is usually placed anteriorly to the lumbar vessels. On the left side this [illegible] has not been met, but in young subjects the lumbar arteries can be mistaken for rami communicantes which they sometimes resemble in size and direction.

In defining the sympathetic trunk long blunt dissection [illegible] necessary. A long probe with [illegible] handle and curved at its end like [illegible] hook, is useful for lifting the sympathetic trunk when defining its branches. Long

straight or slightly curved artery forceps, 20 centimeters long, are also essential and four should be provided. The structures of the abdominal wall and abdominal viscera [illegible] large, broad and deep retractor. The sympathetic trunk and the rami communicantes should be clearly defined before section. The method of dividing the rami communicantes is usually by

[illegible] of the [illegible] the [illegible] of the [illegible] (Cotunnius)

[illegible]. Each ramus may be seized by [illegible] pair of artery forceps and drawn away from its lateral connections, though in many instances [illegible] necessary to divide [illegible] with [illegible] long pair of blunt-pointed scissors. When [illegible] of the second, third, and fourth lumbar nerves has been effected, the ganglionated cord [illegible] then divided at [illegible] level corresponding in position to the fourth lumbar nerve. The operation is then completed. The edges of the lumbodorsal fascia are first sutured to the region of the [illegible]. The oblique muscles are then sutured to the crest of the ilium and [illegible] special

point is made of suturing the tendinous portion of the external oblique to its original attachment and to the adjacent fascia lata. When this is done carefully the raw area on the crest of the ilium comes in contact with [illegible] raw area of considerable width on the under surface of the external oblique tendon and this facilitates adhesion. The lumbodorsal fascia and the latissimus dorsi muscles are then sutured. The skin is closed without drainage.

SINGLE TRANSABDOMINAL INCISION FOR THE EXTRAPERITONEAL APPROACH TO THE LUMBAR GANGLIA

C. E. Rowe approaches the lumbar ganglia through [illegible] single transabdominal extraperitoneal incision as follows.

Step [illegible]. Make [illegible] midline incision through skin and fat extending from the symphysis pubis to one inch below the umbilicus.

Step 2. Develop the incision into [illegible] Y with its upper limbs extending on each side of the umbilicus over the inner one-third of the rectus muscle to [illegible] point midway between the xyphoid and the umbilicus (Fig. 652 A).

Step 3. Separate the superficial fascia from the inner halves of the rectus sheaths on each side in the lower part of the incision, to [illegible] point in the same lateral plane as the upper limbs of the incision.

Step 4. Make [illegible] longitudinal incision in each rectus sheath so that one-third of the muscle lies medial and two-thirds lateral to each incision.

Step 5. Incise the rectus muscle in the same plane, carrying the exposure to the posterior sheath of the rectus in the upper three-fourths and to the peritoneum in the lower one-fourth of the incision (Fig. 652 B).

Step 6. Separate the posterior sheath from the peritoneum by inserting [illegible] finger between these structures lateral to the outer border of the rectus muscle. The separation is carried onward toward the midline by digital dissection. (This approach is necessary for the development of this plane.) (Fig. 652 B)

Step 7. Incise the posterior sheath, not the peritoneum, lateral to the deep epigastric artery leaving the artery on the medial side of the incision (Fig. 652 B).

Step 8. Place the patient in the low Trendelenburg position.

Step 9. Separate the peritoneum laterally from the abdominal fascia and retract the abdominal contents toward the opposite side exposing the aorta and iliac vessels on the left and the vena cava and iliac vessels on the right (Figs. 652 C and D).

Step 10. Close in layers with single continuous chromic catgut sutures the posterior sheath and muscle and single interrupted chromic catgut sutures with simple square knots the anterior sheath, the latter is reinforced with figure-of-eight silkworm-gut sutures.

Step [illegible]. Insert figure-of-eight sutures in the branching limbs of the incision, the lower loops of these sutures alternate on opposite sides of the fascial incision, one suture passing through skin and fat and looping through the right rectus sheath to exit through the fat and skin on the opposite side; the next suture passing through the skin and fat and looping the left rectus sheath to emerge through to the fat and skin. One end of each superficial loop of the figure-of-eight sutures, after emerging from the skin, is

extremities, it may be said that the most urgent indication for their relief is endarteritis obliterans. It should be stressed that endarteritis obliterans, the so-called thrombo-angiitis obliterans, juvenile or spontaneous gangrene, etc., an autonomous disease, to be distinguished especially from arteriosclerotic and diabetic gangrene which should never be designated loosely by any of the above names. Pathogenetically this disease which occurs with preference in young adults, is due to chronic toxins such as nicotine, lead, etc., toxic diseases, such as typhoid fever and pneumonia, and thermic injury such as cold and freezing. Constitutional factors, for instance, nervousness of the vessels, play an important role of course, but are seldom recognized before an operation reveals them. Contrary to syphilitic changes, which are located in the aorta, the endarteritic changes, as their name indicates, are located in the intima.

The first symptom of endarteritis obliterans [illegible] lesion of the big toe. This lesion is often reported to have appeared after an injury from cutting [illegible] nail. The gangrenous, as well as the pregangrenous stage, is associated with the most excruciating pains. Absence of the pedal pulse [illegible] not pathognomonic, since *many healthy people are found without this pulse. The fact, however, that the* pulse reappears during general anesthesia speaks for [illegible] spastic component. This might be used as [illegible] test for the selection of the therapy or operative indication. The same is true of lumbar anesthesia, but especially of capillary microscopy.

It [illegible] matter of fact that every endarteritis obliterans is at first treated conservatively, but one may rightfully wonder why the most central operation—*resection and removal of the lumbar ganglia—is not performed immediately* after the diagnosis is made, or very soon, at least before the onset of gangrene, since gangrene is always irreparable. Internists should not demand of the surgeon therapeutic miracles.

Medical therapy of endarteritis obliterans—recommended for the sake of completeness—includes glyceryl trinitrate, sodium nitrite, kallikrein, acetylcholine, papaverine intravenously, strychnine, diuretin, 5 per cent, common salt solution intravenously, etc.; physical measures are diathermy, alternating hot and cold baths, dry heat, oil baths, short wave, roentgen and radium.

SURGICAL TREATMENT

Epidural anesthesia of the roots of the sciatic nerve with novocaine or alcohol.

2. Arteriography—Mandl had no results in three cases, but Ilgenstein and Dörpel among others recommend the method for diagnosis as well as for therapy.
3. Periarterial sympathectomy (Leriche) performed on the femoral artery above the bifurcation, should be used more frequently in early cases. Mandl adds sympathico-diaphtherese, that is, destruction by [illegible] chemical agent, to the mechanical detachment of the arterial sheath. Incidentally Leriche's operation is also indicated in traumatic edema, trophic disturbances, severe dermatitides, eczemas, ulcer of the lower leg, Roentgen-ulcer and poorly healing fractures. Jaschul has performed it with advantage on the carotid artery in [illegible].
4. Freezing of the exposed and anesthetized sciatic nerve according to Lawen and Wachsmuth by means of carbonic acid or ethyl chloride. Mandl has treated three cases, with success in one.

5. Arteriectomy (Leriche).
6. Lumbar ganglionectomy (Leriche, Fontaine, Royle and Hunter) (vide supra).
7. Chordotomy. Atherosclerosis is an absolute contraindication.

DENERVATION OF THE ADRENAL GLANDS FOR NEURO-CIRCULATORY ASTHENIA

Based on favorable results of experimental investigations of the adrenal-sympathetic system and on conclusions drawn from operations on the thyroid-sympathetic system in cases of hyperthyroidism, Crile sought to control certain pathogenic energy-transforming diseases, particularly those due to pathologic activity of the adrenal-sympathetic system. To this end, he has performed operations on the adrenal-sympathetic system in 126 cases.

Anatomic Considerations. The technic of adrenal denervation requires precise knowledge of the anatomy of the adrenal glands especially in relation to their nerve and blood supply and to their position with relation to other organs.

The adrenal gland is [illegible] yellow pancake, golden in color, soft, friable and vascular. As indicated by its name, [illegible] situated adjacent to the upper posteromedial aspect of the kidney and always close to the vertebral column. An arrow piercing both adrenal glands would pass approximately through the center of gravity of the body. The gland is held in place by strands of the sympathetic web, by the slender fibers from the neighboring fascial planes, and by its blood vessels. It [illegible] completely embedded in fat and, on palpation, the adrenal border gives an impression unlike that of any other organ except the external ear to which [illegible] is similar in texture and mobility.

Precautions. The artery may vary in direction.

The right adrenal gland lies in proximity to the diaphragm, the vena cava, the liver, the head of the pancreas, the duodenum, the kidney and the vertebral column. The left adrenal gland lies in proximity to the tail of the pancreas, the spleen, the aorta, the diaphragm and the spinal column.

When the fascial sheet which binds the kidney to its bale of fat is opened, long blood vessels may be seen passing downward at the side of the kidney toward the vertebral column. These vessels are arrows which mark the trail to the adrenal gland. Generally there is an artery at the outer border of the adrenal and one also at the lower border, the largest artery being underneath, like the stem of [illegible] toadstool. From the adrenal glands thirty or more nerves emerge, and these are found on all aspects of the gland except the anterior surface where they appear at the border.

In hyperthyroidism, the adrenal gland is greatly changed as to its vascularity, its adhesion to neighboring tissues, its appearance and its texture, just as in hyperthyroidism the hyperplastic thyroid gland differs from the normal gland in respect to vascularity, adhesions, texture and appearance.

In the course of manipulations incident to the exposure of all aspects of the adrenal gland and to the division of the nerves, oozing and sometimes smart bleeding are encountered. In no case, however, has Crile found it necessary to tie [illegible] vessel because, happily, in this deep operative field clotting is spontaneous. This may well be accounted for by the fact that adrenalin facilitates the clotting of the blood, as demonstrated by Cannon.

Many years ago in researches on blood pressure, Crile found that, during manipulation of the adrenal gland, an immediate rise in the arterial blood pressure occurred and that immediately after manipulation the arterial blood pressure fell.

Surg., Gynec., and Obst., February, 1932.
This was personally demonstrated to the author by Dr. Crile in four operative cases.

Crile found from these researches that the only gland or tissue in the splanchnic area, the manipulation of which caused [illegible] rise in blood pressure, was the adrenal. The manipulation of every other gland in the splanchnic area caused either [illegible] fall in blood pressure or produced no effect.

Crile Technic

Except in cases of high blood pressure, spinal anesthesia is the method of choice for denervation of the adrenal glands, since it produces complete relaxation and lessens bleeding. The alternative to spinal anesthesia is local and regional block anesthesia combined with analgesia or with nitrous oxide or ethylene. If the operation is being performed under local and regional anesthesia, then the adrenal glands, themselves, are blocked with novocaine, since, although they lie among tissues which are only slightly sensitive to pain, they themselves are sensitive.

In several cases with the patient in the prone position on the table, Crile has made the approach along the lumbar muscles through [illegible] vertical incision, believing that in this way he would approach the gland on its posterior aspect and by [illegible] shorter route. The special advantage of this method was that the nerves and blood vessels could be seen more directly, but the procedure had limitations due to the position of the patient on the table.

Crile has also made [illegible] vertical incision toward the anterior aspect of the adrenal along the tip of the twelfth rib but this method entailed too much contact with the peritoneum.

Recently Crile's method has been to make [illegible] modified kidney incision. This incision, running from behind forward, terminating at about the middle of the twelfth rib, and is then carried downward vertically (Fig. 649a). The incision must be large enough to admit the hand into the renal space. Every bleeding point must be securely tied before the deeper dissection is begun. Since good exposure is essential, by means of [illegible] right angled retractor the twelfth rib is raised and the bloodless field is disclosed. After the renal fascia has been adequately incised, [illegible] long vessel may be seen in the renal fat, the vessel which, as stated above, marks the trail to the adrenal gland. The first step is to mobilize the upper pole of the kidney and to depress the entire kidney when usually the yellow curved edge of the adrenal pancake may be seen. If the adrenal is not seen, the hand is introduced, and by palpation toward the vertebral column and the great abdominal vessels, *the external crinkle border of the adrenal will be felt* (Fig. 649b). At this point special instruments are introduced—namely long slender dissectors at one end of which [illegible] dull dissecting blade and at the other end [illegible] blunt hook. In addition, Crile uses [illegible] pair of blunt nerve hooks on [illegible] long shaft, [illegible] pair of French intestinal forceps, [illegible] small dissecting knife, [illegible] fork retractor and [illegible] pair of curved tonsil scissors (Fig. 650). These special instruments were constructed by Mr. V. B. Seitz of the Cleveland Clinic.

The softness and brittleness of the gland preclude grasping [illegible] as an instrument in order to hold it and orientate its position and also, owing to the nerve and blood vessel attachments, the gland can be moved only within [illegible] very short radius. For these reasons the operation must be carried out essentially in situ.

After the gland has been exposed by separating the fat, the blood vessels [illegible] identified, and then, by means of the blunt nerve hooks, small strands and

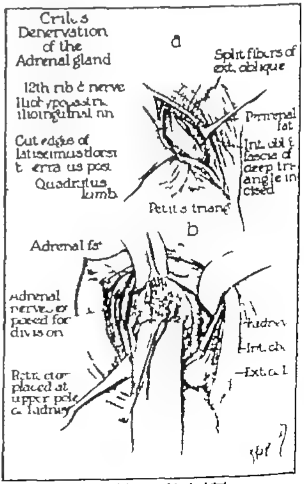


Fig. 649. Crile's denervation of the adrenal gland.

long handled [illegible] knife, the nerves are divided. When this procedure has been completed, the adrenal gland will be quite mobile. It can then be raised up vertically from the vertebral column for a considerable distance.

Fig. [illegible] Crile instruments for adrenal denervation.

Owing to the [illegible] retroperitoneal tissue and the danger of oozing, Crile has usually inserted two cigarette drains, in the [illegible] of which [illegible] gauze has been placed. The [illegible] is used to prevent the [illegible] of the blood serum along the drains [illegible] from the skin. The im-

portant point to remember is that, in approaching the glands, rapid attention should be paid to landmarks and the operating field should be bloodless.

Immediate Operative Results

Crile comments:

"Since the operation is performed in a territory of meager sensory innervation, and the blood loss is slight, there is but little shock. In [illegible] cases, there have been no deaths from anesthesia, pneumonia, shock or hemorrhage. There have been two physiologic deaths, but such deaths are now easily avoidable.

"It is most important to state again that the clinical results in cases of disease of mental or psychic origin, which may be confused with neurocirculatory asthenia, are negative. The differential diagnosis can be made with reasonable certainty by a careful history and physical examination.

"The first point in the diagnosis is to make certain that the mental and psychic mechanism is normal. Then if an unstable heart is found, as manifested by tachycardia induced by trivial causes, or by no apparent cause such as by changing posture, by turning over in bed, by standing up, by slowing of the heart rate when the patient bends over, by any alterations in the heart beat up to and including paroxysmal tachycardia; if the pupils dilate as the result of pressure on the region of the epigastrium; if leipon, tremors, sweating and cold hands and feet are present, if there are uncontrollable nervousness and tremors; if there are intermittent nervous excitation and fatigue; if infections and heart lesions are excluded, then the diagnosis of neurocirculatory asthenia may safely be made.

"The heart cannot initiate tachycardia, but tachycardia is imposed upon it; the sympathetic system cannot initiate stimulation; stimulation is imposed upon it. Our purpose in these cases, therefore, is to interfere surgically with this pathologic stimulation by denervating the adrenal glands, and we are finding the clinical results comparable to the results of thyroidectomy in cases of hyperthyroidism. So also 'soldier's heart' could have been relieved by adrenal denervation.

"The day following the first denervation the patient will notice a lessening of consciousness of his heart; he will experience a diminution of the feeling of nervous tension; he will observe a lessening of the cold sweat, a warming of the skin; and the nurse will notice that the patient is less restless—a sequence similar to that which is observed after thyroidectomy for hyperthyroidism. If the first denervation produces none of these beneficial results, it will be because the diagnosis is incorrect. If correct the second denervation will be followed by further improvement along the same lines, and the general improvement in these cases continues steadily just as in the cases of hyperthyroidism."

Among the important but frequent results is the disappearance of constipation and indigestion.

As to the end-results in our cases, [illegible] patient has remained well for [illegible] years after unilateral adrenal sympathectomy [illegible] in [illegible] years after unilateral denervation; and of the [illegible] cases of bilateral denervation performed within the past [illegible] months, [illegible] patients have remained well to date, in [illegible] cases the results are negative, and [illegible] patient we have been unable to trace. The final decision as to the potency of adrenal denervation must await the test of time.

CHAPTER 21

SURGERY OF THE VASCULAR SYSTEM

OPERATIONS ON THE ARTERIES

ARTERIORRHAPHY

Historical Notes. Halsted and Lambert in [illegible] closed a small wound in the brachial artery by passing a pin through the edges of the wound and winding a thread around it—thus in the old method of securing harelip. Including these three operations, to the fact that it is possible to suture a wound in the wall of an artery with the possibility of maintaining the circulation through the sutured vessel uninterrupted and without causing subsequent aneurysmal dilatation. The old belief that a suture in the wall of an artery gives rise sooner or later to an aneurysm is, in view of these studies, a fallacious assumption.

Indications for Arteriorrhaphy

Wounds of large arterial trunks.
The removal of an embolus.

Essentials for Successful Arteriorrhaphy

Perfect asepsis.
Clean cut wound.
3. Freedom from tension on the sutures.
Careful handling of the vessels sutured.
5. An efficient non-traumatic method of obtaining temporary hemostasis.
Proper suture material.

Operation

Step [illegible]. The vessel is exposed for an inch or more on each side of the wound in it. Clamp the vessel above and below the area to be repaired with a suitable clamp such as Crile's or Sprench's clamp (Fig. [illegible]). If these clamps are not available, fine linen tape thrown around the vessel and fastened with an artery forceps, or with a knot, will form an efficient substitute. Carrel and Guthrie [illegible]: A tourniquet should be used whenever possible (Figs. [illegible]).

Step [illegible]. Gently remove all blood clots; flush with normal saline solution or citrate solution.

Step 3. If the edges of the wound are lacerated, trim them with a fine scissors. Coat the vessel inside and out with sterile vaseline (Carrel).

Step 4. Evert the external sheath of the vessel carefully because if fibers of this sheath find their way between the edges of the wound, thrombosis will promptly follow. Figures [illegible] and [illegible] illustrate various methods used in applying provisional hemostasis.

Comments. A clamp tourniquet made of steel, strong, yet light, [illegible], reliable and practical has been devised by H. Cohen (Fig. [illegible]). It may be sterilized when necessary, as in blood transfusion. Application is made very quickly and results in hemostasis. A fine adjustment screw regulates.

from pressure after the clamp is applied; the pulse may be made to disappear or to be felt by a few manipulations of this screw. Where an assistant are

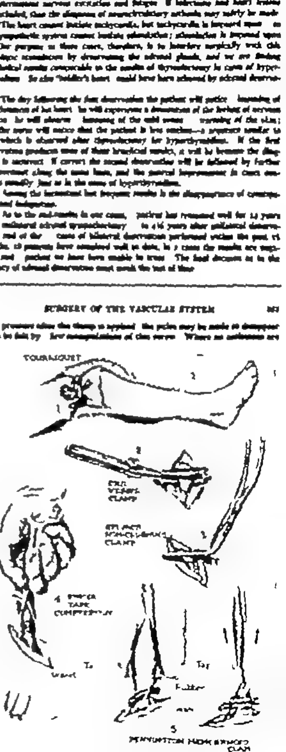


Fig. [illegible]. Methods of temporary hemostasis. (Courtesy of Dr. R. W. McNealy.)

available it is very helpful when injecting solutions intravenously. The vein is made prominent by applying the clamp; the needle [illegible] into the vein and by means of a fine adjustment screw [illegible] may be released without disturbing the needle. The

injected without any further assistance. It is useful in taking blood for blood-chemistry and in controlling hemorrhage in lacerations of the radial artery. Instruments for blood vessel surgery should be of the finest type (Fig. 634).

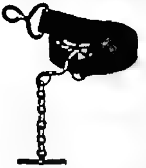


Fig. 634. [illegible]

Robert L. Payne has devised an improved hemostatic forceps. He points out that hemostats as now found on the market are manufactured with single ratchet notch situated only on one shank of the instrument. No matter how sturdy the clamp may be made, its life depends upon the life of the ratchet. When this is worn down, the artery forceps becomes useless. Payne has designed an artery forceps with three ratchet notches on each shank of the instrument (Fig. 635). This feature offers two factors not found in any of the forceps now on the market. First, the Payne forceps offers 3 times the holding strength when applied to pedicles for short or long time because of its 3 notches on either shank. It obviates the necessity for tying the handles when clamps are to be left in situ for any length of time. An important feature is also the economy effected, because the clamps of the Payne instrument will last three times as long as the ordinary one.

Fig. 635. Henry Cohen clamp [illegible].

Sutures may be interrupted or continuous; the latter is preferred.

The needles must be very fine, round, straight or curved (Cushing type). Suture-material consists of very fine silk or linen run through sterile vaseline before use; one silk or linen swedged on proper sized needle is excellent for the purpose. Irregular wounds should be trimmed. Mattress sutures may be used with the edges of the wound everted.

Eversion Method—Briant, [illegible]—Dorrance' Arteriorrhaphy Suturing Longitudinal Incisions

Step 1. The tourniquet or clamps are applied as before. The needle enters close to one end of the incision. It penetrates, if possible, the adventitia and media

Amer. Jour. Surg., May, [illegible]

only. It is brought out and tied. The free end is left long. The needle then penetrates the wall of the vessel, from without inward on one side of the cut in the artery as near the edge as possible. It is then made to penetrate the walls of the vessel on the opposite side of the opening from within outward. The illustration depicts the progress of the suture-line in mattress fashion throughout the length of the wound (Fig. 637). At every third loop carry the stitch back to add stability. At the other end, the suture is passed through the two outer coats of the vessel near the end of the incision and tied.

Step 2. Reinforce by second continuous running suture, picking up the edges of the incision between the loops of the mattress suture. When the suture reaches the end of the suture line the two ends are knotted together. The vessel thus sutured results in an approximation of the intima on both sides; the suture is buried and out of the current line.

Step 3. Remove the clamps, first from the distal then from the proximal end of the sutured vessel. Make sure that there is no escape of blood along the suture line. Suture the fascia loosely over the sutured artery; close the skin.

End-to-End Suture

Step 1. Apply the clamps as in the previous procedure.

Step 2. Grasp the edges of the artery with two forceps. Introduce mattress suture first; pass the needle through all the coats of the artery from without inward. Continue the suture as continuous mattress suture—dropping back half stitch every third suture until the starting point is reached (Fig. 638). Here a half stitch is made and the suture is continued back as lip-stitch until it reaches the starting point. The two ends are then tied. The suture is started on the anterior surface near the handle of the clamp.

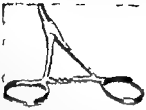


Fig. 636. Payne' [illegible] forceps.

Step 3. When the suture reaches the farther side of the artery the handle of the clamps are removed from the lower portion of the vessel and placed at the upper portion. Thus, the surface of the artery which was anterior now posterior. In this manner the suture line is constantly under surveillance. (The illustrations (Figs. 637–638) depict continuous suturing method of the mattress suture as described.)

LIGATION OF ARTERIES

Ligation or tying of blood vessel (artery) means the shutting off of the arterial blood flow in the artery itself and its branches below the place where the vessel tied. This surgical step may be necessary on account of hemorrhage from the vessel, which if not prevented may lead to the loss of the patient's life; or during an amputation of the whole or part of an extremity, or the removal of diseased organ; also in cases of pulsating tumors, such as aneurysms or where

it is desired to cut off the nutrition and reduce the rate of growth of certain types of tumors.

It goes without saying that every surgeon should be intimately acquainted with the position, relationship, course, connections, branches, and functions of every important artery in the human body. The method of approach to an artery and the structures intimately associated with it at every point of its course should be matters of intimate familiarity to the surgeon. Not only that, but the possibility of anomalies, either in the artery itself or in the structures associated

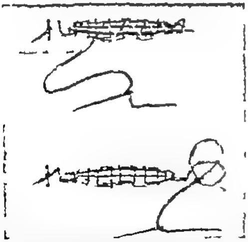


Fig. 637. Dorrance's method of suturing an artery. The suture used for closing longitudinal wound in an artery. The [illegible] [illegible] [illegible] [illegible]

with it are matters to be reckoned with. Much of this knowledge will be assimilated in the dissecting room but the more important details and questions of technic will properly be stressed in surgical, clinical, or postgraduate courses.

Before proceeding with the surgical steps necessary for the ligation of main artery it is often advantageous to secure temporary hemostasis by tourniquet applied over vessel well above the line of amputation (Figs. 639–640). When operating in areas where such step is impossible, secure the main vessels by [illegible] before dividing them. The larger vessels are secured by ligature; all vessels may be picked up with forceps, and bleeding may often be arrested [illegible], torsion and electrocoagulation.

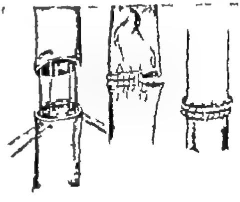


Fig. 638. Dorrance method of vessel repair. A. [illegible] B. [illegible] C. [illegible]

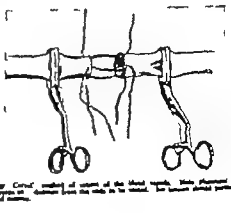


Fig. 639. Carrel method of suture of the blood vessels. [illegible]

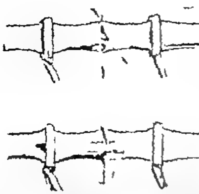


Fig. [illegible]. Upper figure [illegible]. Lower figure [illegible].

Fig. [illegible]. Application of Esmarch's tourniquet to the groin to compress the femoral artery. The tourniquet should be applied over [illegible] wood.

It is important to remember that [illegible] healthy part of an artery always should be selected for ligation. Remember that in crushing injuries to the limbs, one or more vessels may be badly damaged.

Fig. [illegible]. Esmarch compression of the femoral artery. The tourniquet is applied over [illegible] wood.

For the successful execution of ligation of an artery, the following three successive steps are paramount:

Orientation of important adjacent structures.
Isolation of the artery at the point selected for ligation.
3. Proper ligation.

All arteries lie beneath the deep fascia and the search for the particular vessel must proceed methodically step by step. The course of the principal vessels should be known before hand. The artery is approached at the selected spot by dividing the skin and deep fascia and by separating muscle groups and

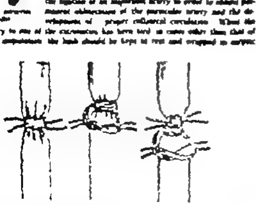
lateral planes. The connective tissue sheath of the artery should be opened longitudinally for about three-fourths of an inch over the course of the vessel and the surgeon must make sure before passing the ligature that the vessel is quite free all around the selected level. The ligature [illegible] passed by means of an aneurysm needle (Fig. [illegible].)

Fig. [illegible]. Aneurysm needle.

The stay knot method of tying is best used in the case of larger vessels (Fig. [illegible].) The degree of pressure should be such as firmly and completely to approximate the vessel walls without rupturing the inner or middle coats.

If, [illegible] while ligating an artery [illegible] large vein should accidentally be punctured, withdraw the needle at once and take care of the puncture point by pressure or ligature. The artery in such cases should be tied at [illegible] little higher or lower level.

In other than urgent amputation cases, the patient should be kept at rest for at least three weeks following the ligation of an important artery in order to obtain permanent obliteration of the particular artery and the development of [illegible] proper collateral circulation. When the main artery to one of the extremities has been tied in cases other than that of an urgent amputation, the limb should be kept at rest and wrapped in cotton



A B C

Fig. [illegible]. Ballance and Edmunds' [illegible] stay knot method [illegible] closing large blood vessel. [illegible]

batting. Watch for signs of threatening gangrene. Avoid pressure-sores and burns.

Fig. [illegible]. Digital compression of the subclavian artery.

Fig. [illegible]. Momburg's method of manual compression of the abdominal aorta.

There are two dangers likely to follow the ligation of any artery but especially that of the larger vessels. First, secondary hemorrhage. If the inner and middle coats have been severed by the ligature. When this happens, the crumpled adventitia (exposed by the retraction of the intima and media) is insufficient to withstand the blood pressure and undergoes aneurysmal dilatation followed by hemorrhage. *Second, gangrene may arise from one of several causes.* There may be a loss of vitality on account of faulty collateral circulation; severe secondary hemorrhage due to causes already mentioned may be responsible for serious trouble; there may be interference with the venous return-flow; finally, unsuitable therapy (such as the injudicious use of heat or cold) may set up gangrene.

Temporary Arrest of Hemorrhage

Tamponade
Digital compression of the efferent vessel.
3. Tourniquet pressure proximal to the bleeding area
4. Temporary ligation of vessels around an area to be operated on

Tamponade. Sterile gauze strips are used here. A tampon may not only subserve the purpose of temporary hemostasis, but also in cases where a larger vessel that cannot be located is bleeding, firm compression against a non-yielding surface will seal the lumen and permanent arrest of blood will result. In large bleeding spaces the Mikulicz tampon is useful.

Manual and *Digital Compression* of the efferent vessel is of utmost importance in emergencies. *It is of temporary nature, of course, until other methods may be applied to control the bleeding (Figs. 643-644).*

Tourniquet Pressure. This is made either by rubber tubing, Esmarch Constrictor, broad rubber bands or cuff of blood pressure apparatus (*Figs. 643 and 644*). The compression, while effective, may cause temporary injuries to the muscles and nerve structures. Permanent paralysis may also result.

The Esmarch method of using the tourniquet consists of applying tightly from below upward, in an even spiral without overlapping, an elastic rubber bandage carried as high on the limb to be amputated, as necessary. Immediately above it an elastic band or tube is firmly wound around the limb with sufficient force to arrest all arterial bleeding. The tourniquet is then fastened by a clamp or spring and the elastic bandage is removed from above downward. Instead of bandaging, the limb may be elevated for about three minutes, massaging the limb toward the trunk of the body.

Matas urges that the following be observed in using the tourniquet:

Always apply the elastic tourniquet over the femoral or humeral shaft, or at such points that no vessel can escape a circumferential compression.

"Begin by compressing the vascular or adductor side, leaving the outer or extensor surface of the limb free from pressure, so that venous choking of the limb may be avoided.

"Separate each turn of the constrictor by an intervening space to distribute the pressure.

"Do not allow the constricted member to be suddenly flexed or extended after the constrictor is in place for fear of bruising subcutaneously the underlying muscles and nerves.

"Do not keep the constrictor in place much longer than an hour or an hour and a half."

FIG. 643. Application of elastic rubber bandage (Esmarch) to the lower extremity.

It has been objected, with good reasons, that the ischemia of a limb obtained by forcible elastic compression:
1. is likely to be followed by excessive capillary oozing
2. increases the risk of embolism and of tumor metastasis
3. greatly favors the absorption of toxic chemical antiseptics
4. increases the liability to ischemic necrosis.

For these reasons Matas considers elevation and massage superior to the elastic compression bandage preliminary to the application of a tourniquet.

Temporary Ligation Around an Area to be Operated on is usually used, as in Heidenhain's delegations, to secure hemostasis in operations on the skull and brain (Fig. 644).

Permanent Arrest of Hemorrhage

This is, as stated above, accomplished by ligation of the vessel. The instruments used in the operation for ligation of arteries are:
Scalpels
Anatomic forceps
Blunt hook

Hemostatic (artery) forceps
Aneurysm needle (ligature carrier)
Ligature materials

Step 1. Determine the course (line) of the artery. Make an incision along this line, holding the knife like a violin bow. Do not tear subcutaneous structures; divide them with a sharp knife. Arrest hemorrhage as it occurs (torsion of vessel, ligature, electrosurgery).

Step 2. It is best to locate the artery with the finger (feel for pulsation). Do not mistake veins or nerves for arteries. Nerves stand out as white cords;

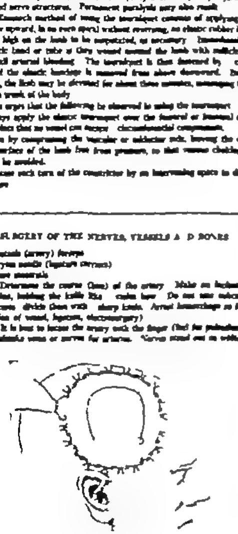


FIG. 644. Heidenhain. Delegations to secure hemostasis in operations on the skull and brain.

veins are of a purple color. Softer than arteries, nerves and artery so common. Each artery of the upper extremity and each artery below the knee is accompanied by two veins (venae comites). The arteries of the head and neck, except the lingual have each a single accompanying vein. The lingual artery has venae comites, as have most of the smaller arteries of the trunk, penis, external mammary, etc.

Step 3. In opening the sheath of the artery pick the sheath up with toothed forceps so as to create a transverse fold, thus avoiding impinging upon the artery or vein. Lift the fold to see that it is free; open the sheath by cutting toward the edge of the forceps with a scalpel held obliquely with its back toward the vessel, making a longitudinal incision. Hold the edge of the incised sheath with the forceps; pass a blunt dissector under the vessel. Grasp

the other edge of the sheath and pass the blunt dissector all the way around the vessel.

Step 4. Pass an aneurysm needle under the cleared vessel. Thread the needle and withdraw the ligature carrier. If venae comites are in the way try to

FIG. 645. Deep arteries of the neck, viewed from the right. (Spalteholz.)

separate them. If this proves difficult include them in the ligature. Tie the ligature with a reef-knot. It is not necessary to rupture the intima and media to insure obliteration (Ballance, Edmunds, Scarpa, Sir Philip Crampton).

Ligation of Arteries in the Head and Neck Region

Ligations of the arteries in the head and neck region are mainly indicated for hemorrhages and for spreading infections. The principal arteries involved

Arteries of the Neck

Fig. 668. Superficial arteries of the neck. (Sobotta.)

in the head and neck region are: the vertebral, the common, the external and internal carotids and their branches, the superficial temporal artery, the occipital artery, the middle meningeal, the lingual and facial arteries.

Ligation of the Vertebral Artery

Anatomical Considerations. (Fig. 667.) Ligation of the vertebral artery may be required for stab wounds or traumatic aneurysm. It is very difficult to perform on account of its deep position and the important structures that surround it.

This vessel arises from the upper and posterior portion of the first division of the subclavian artery close to the inner border of the anterior scalenus muscle; then passes directly upward along the anterior surface of the vertebral column, entering the foramen in the transverse process of the sixth cervical vertebra. It then ascends through the foramina in the transverse process of all the vertebrae above this, coursing then between the transverse processes of the atlas and axis, finally piercing the occipito-atlantoid ligament.

There are two methods of ligating this vessel:

By an incision made below the omohyoid muscle, which is divided together with the fascia; locate the inferior thyroid artery first. When this latter artery is found it is drawn downwards and the vertebral artery is then exposed by blunt dissection just below and behind the tubercle of the sixth transverse

Fig. 669. Digital compression of the common carotid artery.

process and just before it enters the bone; great care must be taken not to injure the cervical plexus, the branches of which are in close proximity.

By an incision made along the lower half of the posterior border of the sternomastoid muscle. The anterior scalenus muscle and the phrenic nerve are exposed until the transverse process of the sixth cervical vertebra is defined in the gap between this muscle and the longus colli. Just below this, the vertebral artery will be found entering its bony canal. Avoid injury to the cervical sympathetic and phrenic nerve.

Ligation of the Common Carotid Artery*

Indications.

1. Wounds of the vessel.
2. Aneurysm of the innominate artery or the aorta.
3. Aneurysm of the carotid trunk or its main branches.
4. Aneurysm in the orbit.
5. Temporary ligation to control bleeding during removal of tumors of the head and face.
6. Hemorrhage (carcinoma of the face and tongue; hemorrhage after tonsillectomy, etc.)

* In emergencies the common carotid artery may be compressed digitally as shown in Fig. 669.

The common carotid artery (Figs. 668-669) enters the neck deep and posterior to the sternoclavicular joint. Between the upper border of the thyroid cartilage and the great cornu of the hyoid bone the main vessel bifurcates into the external and internal carotid arteries. The internal carotid may be considered as the continuation of the common carotid artery and the external as a branch of the

Fig. 670. Lines of incision for the exposure of the carotid and internal carotid arteries. [illegible]

incision. The common carotid is usually ligated above or below the anterior belly of the omohyoid. (Figs. 670-671.) It may be ligated at any part of its course. The place of election, however, is at the level of the cricoid cartilage above the upper border of the omohyoid muscle.

Ligation of the Common Carotid Artery Above the Omohyoid

The artery is more superficial here; hence this point is spoken of as the "point of election." The patient is placed on his back with the shoulders slightly elevated and the head turned to the opposite side (Fig. 671).

An incision about three inches long is made in the line of the artery with its

center opposite the cricoid cartilage. The skin, fascia and muscles are retracted downward and the sheath of the artery is seen first with the descendens hypoglossi nerve lying upon.

The sheath is opened, the artery is exposed and tied.

Ligation of the Common Carotid Artery Below the Omohyoid

An incision 3 inches long is made over the line of the artery and extending up from the sternoclavicular joint. The muscles are separated and the omohyoid elevated. It may be necessary to tie and cut a portion of the inferior thyroid venous plexus. The sheath of the artery should be opened on the inner side.

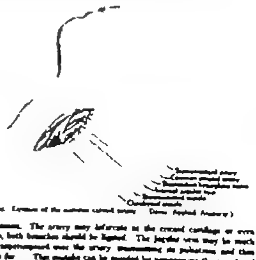


Fig. 671. Ligation of the common carotid artery. (Davis, Applied Anatomy.)

Precautions. The artery may bifurcate at the cricoid cartilage or even lower. If so, both branches should be ligated. The jugular vein may be much dilated, be superimposed over the artery, transmitting its pulsations, and thus be mistaken for it. This mistake can be avoided by compressing the vessel and observing the direction of the column of blood. The thyroid gland may cover the artery. If so, displace it laterally. If the face of the patient be turned too far aside, the incision may be made over the sternomastoid muscle instead of along its anterior border. It is wise to ligate smaller vessels as encountered. Below the omohyoid there is risk of injuring the internal jugular vein. Push it forcibly out of the field of operation. If the vein be accidentally injured there is danger of air embolism. If this happens flood the wound with sterile salt solution. Apply pressure on either side of the puncture. Repair the opening with a lateral suture. Avoid injury to the vagus and sympathetic nerves. In the other complications (cerebral softening, coma, death to per cent) which

may follow ligation of the common carotid artery. Instead the external carotid artery should be ligated.

Collateral Circulation. (Fig. 673.) The superior with the inferior thyroid, the profunda cervicis with the princeps cervicis, branches of the external carotid and the circle of Willis.

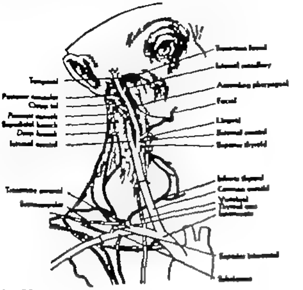


FIG. 673. Collateral circulation after ligation of the common carotid artery. (Davis: Applied Anatomy.)

Ligation of Both Common Carotid Arteries

The surgeon may be called upon to resort to this drastic procedure. It has been accomplished.

Temporary Ligation of the Common Carotid Artery

This procedure has been resorted to in order to arrest hemorrhage from branches of the common carotid. Expose the vessel, pass a ligature around it and lift the vessel sufficiently to close the lumen. The ligature may remain in place for two or three days and then be removed.

Ligation of the External Carotid Artery

Indications.

1. Wounds

2. Uncontrollable hemorrhage from the tonsils
3. Aneurysm of the external carotid artery
4. Temporary ligation during operations
5. To starve malignant tumors
6. Persistent middle meningeal hemorrhage

Neither the common nor internal carotid arteries have any branches (Fig. 673). The external carotid, however, has several branch-arteries, the facial, the superficial temporal, the occipital and the lingual being the principal ones. These will be dealt with below.

The external carotid artery itself commences at the upper border of the thyroid cartilage. The "site of election" for its ligation is situated below the digastric muscle and between the lingual and superficial temporal branches of the artery. An incision 3 inches long is made in the line of the artery along the anterior border of the sternomastoid muscle, the center of the incision being at the level of the hyoid bone. The posterior belly of the digastric muscle and the hypoglossal nerve are identified and the apex of the great cornu of the hyoid bone exposed. The sheath of the artery is opened just below this spot, taking care to avoid the superior laryngeal nerve which lies just below the artery. Care must be exercised to avoid the external jugular vein and its anastomoses with the facial. The border of the sternomastoid must always be kept in view. The external carotid artery itself lies at the level of the great cornu and between it and the vein. (Figs. 674–675.)

Precautions. Both external carotids may be ligated. Make sure before you throw the ligature around the vessel, that [illegible] the external carotid artery. Enlarged superimposed lymph nodes may be mistaken for the vessel. The superior thyroid artery may be mistaken for the lingual, the latter passes upward, the former downward.

Ligation of the Facial Artery

Anatomic Considerations. The facial artery is one of the important branches of the external carotid; it arises just below the tip of the great cornu, about an inch from the bifurcation of the common carotid artery. It passes through the substance of the submaxillary gland and enters the face at the anterior inferior angle of the masseter muscle. It is usually ligated where it crosses the lower jaw in front of the border of the masseter muscle.

The facial artery may be ligated at either of two points.

(a) Just above its origin. The vessel is the fourth branch of the external carotid artery which it leaves a short distance above the great cornu of the hyoid bone; it is ligatured by an operation similar to that for tying the external carotid.

(b) Where it crosses the mandible. The incision is horizontal and [illegible] inch long parallel to and just below the lower jaw. The skin and muscles are then drawn up over the bone and the artery will be found lying upon the bone just in front of the masseter muscle.

Caution.—When ligating the facial artery at its origin do not mistake it for the lingual artery.

Ligation of the Occipital Artery

Anatomic Considerations. The occipital artery arises from the external carotid a little above the facial artery. It courses upward and outward to the space between the transverse process of the atlas and the mastoid process. (Fig. [illegible].)

The occipital artery is ligated best under the mastoid process. It is located by a transverse incision [illegible] inches long ending in front of the tip of the mastoid process. However, the vessel may be ligatured at either of two places.

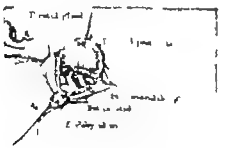


FIG. 674. Exposure of the external carotid artery on the stylo-hyoid before ligation.

FIG. 675. Exposure of the external carotid artery in the carotid triangle.

(a) In the anterior triangle at its origin. Here the operation is similar to that of the external carotid from which it originates.

(b) In the mastoid region. An incision [illegible] inches long is made from the

back of the apex of the mastoid process in the direction of the external occipital protuberance. The posterior part of the sternomastoid and other neighboring muscles are split and the artery is then seen emerging from the groove of the mastoid process in which it lies.

Ligation of the Superficial Temporal Artery (Fig. [illegible])

Anatomic Considerations. The superficial temporal artery is one of the terminal branches of the external carotid. It begins in the substance of the parotid gland between the neck of the mandible and the external auditory meatus. It passes upward across the root of the zygoma. About two inches above the zygomatic process it splits up into its terminal branches.

The artery is reached by a vertical incision [illegible] inch long between the tragus and the condyle of the lower jaw and is best ligated where it lies upon the zygoma just in front of the ear. The vessel is easily exposed but care should be taken not to injure the auriculotemporal nerve.

Collateral Circulation. From the facial vessels and other arteries supplying the scalp.

Ligation of the Lingual Artery

The lingual artery passes between the deep surface of the hyoglossus muscle and the middle constrictor of the pharynx about one third of an inch above the great cornu of the hyoid bone. The artery is deep to the hyoglossus and at a slightly lower level than the nerve. The lingual artery may be ligated at either of two places: (a) at its origin from the external carotid or (b) beneath the hyoglossus in the submaxillary triangle (Fig. 676). The whole region is covered with the submaxillary gland and the border of this gland must be exposed as it is an indispensable landmark.

The incision for ligation at the origin is the same as that for tying the external carotid, the lingual being the second branch given off by that vessel. The external carotid is followed down until the lingual is seen leaving it and lying upon the middle constrictor. In practical surgery the artery is ligated most frequently proximally to the angle the digastric tendon and is searched for behind the posterior belly of the digastric muscle.

The incision for ligation of the lingual artery beneath the hyoglossus is made with the patient lying on his back, with the neck extended and the head turned to the opposite side. The incision in this case is not made over the line of the artery but is curved lying under the lower jaw with its concavity upward. It begins one-half inch below and outside the symphysis menti passing down to the hyoid bone and curving up again to the angle of the jaw. The flap is turned up and the muscle and fasciae separated. The submaxillary gland and the two bellies of the digastric muscle are then exposed. The tendon of the digastric muscle is drawn downward while the hyoglossus muscle is seen in its angle and the hypoglossal nerve passing across it to disappear under the mylohyoid muscle. The nerve is drawn up and the fibers of the hyoglossus muscle divided transversely about one-quarter of an inch above the hyoid bone. The lingual artery will be seen lying beneath the hyoglossus upon the middle constrictor muscle.

Precautions. The hypoglossal nerve may be mistaken for the artery.

hyoglossus; that the nerve rests on the hyoglossus, the artery runs beneath it. Make sure that the structure in question pulsates. Do not mistake the lingual vein for the artery particularly in individuals with chronic heart disease and persons advanced in years (atheromatous thickening of the vessel wall [illegible] of pulsation). The artery may be absent; it may take a higher course or it may run in the substance of the hyoglossus muscle. Search for the vessel, after division of the fibers of the hyoglossus muscle, must be conducted with great care lest the pharynx be opened. The operation for exposure and ligation of this vessel is not an easy one [illegible] too short an incision. The submaxillary

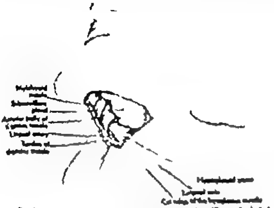


Fig. 6[illegible]. Ligation of the lingual artery at lesser triangle. (Deaver, Applied Anatomy.)

gland should not be incised but the exposure should be rather below these structures which the surgeon should lift out from the field of operation. There is no collateral circulation formed after ligation of the lingual artery.

Ligation of the Internal Carotid Artery

The vessel calls for ligation in

1. hemorrhage from the tonsils
   excision of the tongue
3. wounds of the vessel.

The internal carotid artery lies on a deeper plane than the external carotid. It can only be ligated at its commencement. The incision is the same as that for ligation of the external carotid. On separating the muscles the internal carotid artery will be found lying deeply in the neck (Figs. [illegible]). Care must be taken not to injure the jugular vein, the vagus and sympathetic nerve trunks.

Precautions. The internal carotid artery may arise from the arch of the aorta, be absent or tortuous.

Collateral Circulation. Through the circle of Willis.

Ligation of the Middle Meningeal Artery

(See Operations on the Skull, p. [illegible])

After entering the skull the middle meningeal artery divides into two branches, an anterior and posterior. The anterior branch runs in a canal or groove on the inner surface of the antero-inferior angle of the parietal bone upwards and somewhat backward to the sagittal suture lying about three-quarters of an inch behind the coronal suture. At this point the vessel is about one and a half to one and three-quarters inches above the zygoma. The posterior branch courses upward and backward along the inner surface of the squamous portion of the temporal bone.

Step 1. Anterior Branch. A semicircular flap of about one and one-half inches radius is reflected downward in the temporal region so as to permit the skull being trephined at a point one and one-half inches behind the external angular process of the frontal bone and one and one-half inches above the zygoma, the intervening muscles being split vertically.

Step 2. An opening of about one and one-half inches diameter is made in the skull and the artery will be found either running in a groove or channel in the bone or else lying upon the dura. In the former case the vessel should be occluded by crushing the bone in upon it or by forcing wax (Horsley) or a small wooden peg into the bony canal. In the latter case the artery is occluded by undermining it with a stitch.

Posterior Branch. This may be exposed by trephining the skull in a situation similar to the above only about one-half an inch lower. Farther back this branch can be exposed by trephining one and one-half inches above the center of the base of the mastoid process.

The Main Trunk. This can be ligated by trephining the skull at the same point as for the anterior branch and cutting away the bone for a short distance. It will be easier to secure the vessel if the dura mater is pushed away from the bone for a short distance.

Ligation of Miscellaneous Arteries

Intercostal Arteries. As each of these vessels lies in a groove under cover of a rib, except at the posterior part of an intercostal space, an incision two inches long is made over the rib and about one and one-half inches of the rib are resected subperiosteally. The periosteum beneath the rib is then divided and the artery exposed and ligated.

Internal Mammary Artery

Ligation of this vessel may be called for in amputation of the breast. The artery runs parallel to and about one and one-half inches outside the border of the sternum. A transverse incision one and one-half inches long is made in the second or third intercostal space and running out from the border of the sternum. The muscles are divided including a few fibers of the pectoralis major. The artery lies upon the pleura; care must, therefore, be exercised not to injure the pleura, nor the lung beneath. If preferred, a small portion of the inner end of the second or third costal cartilage may be resected subperichondrially and the artery exposed in this way.

Ligation of the Superior Thyroid Artery

(See Goiter or Thyroidectomy, p. [illegible])

The superior thyroid artery is the first branch of the external carotid artery and its ligation is sometimes called for in cases of exophthalmic goiter. The incision is the same as that for ligation of the external carotid which must be identified and followed down until the branch artery appears.

Ligation of the Inferior Thyroid Artery

(See Goiter or Thyroidectomy, p. [illegible])

As in the case of the superior thyroid artery this vessel is sometimes ligated in cases of exophthalmic and other goiters. The incision is the same as that for ligation of the common carotid artery below the omohyoid. The sternomastoid and the sheath of the carotid sheath are retracted outward while it may be necessary to divide the sternohyoid and sternothyroid muscles. The tubercle of the sixth cervical vertebra should be found at the inner side of the sheath and immediately below this the artery will be seen running directly inward. Great care should be taken not to injure the recurrent laryngeal nerve which splits into several branches before entering the larynx.

Ligation of the Innominate Artery

This important artery has been tied with success on several occasions (Rose and Carlson). An angular incision about [illegible] inches long is made running down the lower third of the anterior border of the inner third of the clavicle. The muscles are divided, the carotid sheath identified and opened and the carotid artery exposed and followed down to the innominate. It is not usually necessary to remove any part of the sternum or clavicle. The important structures to look for and care for are the internal jugular vein, the two innominate veins, the inferior thyroid plexus, the vagus nerve and the pleura.

Collateral Circulation. Intercostal branches of the aorta with the superior intercostal branches of the subclavian and with the thoracic branch of the axillary and internal mammary arteries; also with the [illegible] branch of the internal mammary artery.

The deep epigastric artery, with the termination of the internal mammary.

) Between the branches of the two external carotids and also through the circle of Willis.

Ligation of the Subclavian Artery

Historical Notes. The subclavian artery was first successfully ligated in its third portion by Post of New York (18[illegible]). In [illegible] Sir Astley [illegible] attempted to ligate the first part of the vessel but abandoned the operation [illegible] wounded the thoracic duct. The first successful ligation of the first part of the vessel was done according to Treves, by Colles in 18[illegible]. The patient died. Halsted successfully ligated the first part of the artery (1892) for aneurysm on the left side.

Anatomic Considerations. On the right side the subclavian artery arises from the innominate opposite the junction of the right clavicle with the sternum. On the left side it arises from the arch of the aorta. The right subclavian artery is about three, the left about four inches in length. Each arches upward into the neck to the level of the sixth cervical vertebra. Each vessel is divided into three parts. The first portion is situated between the origin and the inner border of the scalenus anticus muscle; the second portion lies immediately behind the muscle while the third part

bounded by the outer border of the scalenus anticus muscle and the lower border of the first rib.

This artery may be ligated in any of its three parts. Ligation of the first part is practically the same operation as ligation of the innominate artery above the clavicle. The artery is practically never ligated in its second part as it lies under the scalenus anticus muscle (Fig. [illegible]).

Step 1. Place the patient on his back, raise the shoulders, extend and turn the head to the opposite side, pulling the arm down and holding it by pushing the forearm under the patient's back (Treves). This pulls down the clavicle and affords better exposure.

Step 2. Make an incision 3 inches long over the middle third of the clavicle and within half an inch of it. Preserve the external jugular vein if possible; otherwise, ligate and divide it.

Fig. 6[illegible]. Ligation of the subclavian artery. (Deaver, Applied Anatomy.)

Step 3. Divide the muscles, incise the deep fascia and the posterior belly of the omohyoid muscle is drawn up. Avoid the transverse cervical and suprascapular arteries.

Step 4. Identify the external border of the scalenus anticus muscle and follow it down with the finger to the scalene tubercle on the first rib. When the finger rests on the tubercle the subclavian vein will be in front of the finger and farther down into the chest while the subclavian artery will be felt beneath the finger lying in a groove in the rib and then can be exposed. In ligating be careful not to include the cords of the brachial plexus which pass around it or injure the subclavian vein. The artery lies internal to the brachial plexus.

If the field of operation is too small, the trapezius or sternocleidomastoid muscles, or both, should be partly divided, temporarily.

Collateral Circulation. The intercostals and branches of the internal mammary with the thoracic branches of the axillary; other branches of the [illegible] with the suprascapular and posterior scapular arteries.

Ligation of the Axillary Artery

Anatomic Considerations. The axillary artery begins at the lower border of the first rib and extends to the lower border of the tendon of the teres major muscle. It gives off numerous branches. It is intimately connected with the brachial plexus. It may be ligated in three situations: ( ) above the pectoralis minor; (b) behind the minor; (c) below that muscle. Only the first or lower and third parts of this artery can be ligated.

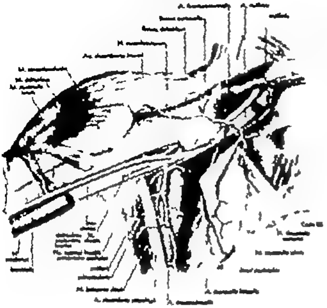


Fig. [illegible]. Arteries in the right axilla, viewed from in front. (Spalteholz.)

Ligation of the first part of the axillary artery was first performed by Chamberlaine of Jamaica in 1815. The operation is difficult and dangerous. The axillary vein (Figs. [illegible]) closely attached to the costocoracoid membrane may be torn.

Step. The arm should be abducted; the point of the shoulder should not be depressed. An incision [illegible] inches long should be made immediately below the inner two-thirds of the clavicle, although some surgeons advise that the incision should form a curved flap with its convexity downward, which may be reflected up.

Step 2. The clavicular and sternal portions of the pectoralis major are separated from each other and the adjoining tissues are exposed. The costocoracoid membrane is divided, the pectoralis minor muscle is drawn downward and the subclavius muscle is drawn up, the branches of the thoracic-acromial drawn aside and the axillary vein drawn inward; the axillary artery is then exposed. Care must be taken not to include the veins or any of the cords of the brachial plexus in the ligature.

Ligation of the third part. In ligating the artery in this situation, the arm must be abducted to a right angle. An incision 3 inches long is made in the

Fig. [illegible]. Incisions for ligating the arteries of the arm. A, incision for ligating the third part of the axillary artery; B, brachial; C, the artery at the bend of the elbow.

line of the artery (Figs. [illegible]). The neurovascular bundle is exposed in the axilla; it is covered with the median and musculocutaneous nerves which are drawn aside leaving the artery overlapped by the vein. Do not include the ulnar or internal cutaneous nerves in the ligature.

Collateral Circulation. If the ligature is done above the thoracic axis branch, collateral circulation takes place in the same manner as in ligation of the third part of the subclavian artery. If ligated below, collateral circulation takes place by the humeral branch of the thoracic axis with the anterior circumflex vessels and the [illegible] humeral arteries, also by the suprascapular and posterior scapular vessels anastomosing with the subscapular and posterior circumflex arteries.

Precautions. The obesity of the axilla may confuse the surgeon because of large branches that are given off from the axillary at its third portion.

Ligation of the Brachial Artery

Anatomic Considerations. (Fig. [illegible].) The brachial artery extends from the lower border of the tendon of the teres major muscle to about an inch below the bend of the elbow joint. It is closely associated with the veins and nerves of the arm. The

brachial artery is situated on the inner side of the arm; it may be ligated in either of two places.

Fig. [illegible]. Lines of incision for the ligation of the third portion of the axillary, brachial, radial and ulnar arteries. The incision for ligation of the brachial artery in the middle of the arm, the incision for the radial and ulnar arteries [illegible] at the bend [illegible] the incision for the ulnar artery [illegible] of the lower [illegible] The top of the [illegible] and the other on the [illegible]. The curve at the junction of the upper [illegible] middle third of the forearm [illegible] to the junction of the ulnar artery [illegible] upper third [illegible] between the upper right hand [illegible] and the elbow.

Ligation at the Middle of the Upper Arm. The arm is abducted from the side at a right angle (Fig. [illegible]). The incision should be about [illegible] inches long made in the line of the vessel (Figs. [illegible]). The basilic vein and biceps

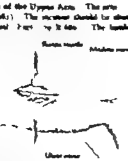


Fig. [illegible]. Ligation of the brachial artery in the middle of the arm showing the median nerve lying on the artery and the ulnar nerve to its inner side. (Davis, Applied Anatomy.)

is not moved out of the way. The artery will be found lying upon the muscle with the median nerve in front of it. There is no [illegible] for

mistaking the basilic vein for the artery as the former is above and the latter is below the deep fascia (Figs. [illegible]).

An alternate method of ligation consists in deliberately opening the sheath of the biceps muscle and passing through it so as to approach the artery from the front.

Fig. [illegible]. [illegible] compression of the brachial artery. [illegible] Esmarch bandage and [illegible] to the opposite shoulder.

Ligation at the Bend of the Elbow. As before, the arm is abducted from the side to a right angle. An incision, [illegible] inches long, is made starting at the middle of the antecubital fossa and running upward and inward parallel to the inner border of the biceps muscle (Fig. [illegible] C). The median basilic vein is drawn

Fig. [illegible]. Arresting hemorrhage by compressing the brachial artery.

aside, the fascia is divided and the artery is found lying in the [illegible] with the median nerve on its inner side and the biceps tendon on the outside. It will be found immediately under the aponeurotic expansion of the biceps muscle on the same level as the outer biceps tendon and is accompanied by two veins. The structures lying behind the median nerve should never be displaced.

Precautions. The arteries of the forearm may spring from the axillary.

the brachial may bifurcate at a high level, or it may run behind the inner condyle along the ulnar nerve. The profunda branches may be mistaken for the main trunk. The incision at the upper two thirds may be made too far upward. In such case, the surgeon may mistake the ulnar for the median nerve. The median nerve may pass behind the artery instead of in front of it; or, the artery may lie deeply between the brachialis anticus and the biceps muscle.

Collateral Circulation. This depends upon whether the artery is ligated above or below the superior profunda. Collaterals: the circumflex vessels, superior profunda and the five anastomosis around the elbow joint.

Fig. 684. Digital compression of the brachial artery.

Ligation of the Radial Artery

Anatomic Considerations. (Fig. 685.) The radial artery arises from the brachial. It is superficial in its course. It is smaller than the ulnar. It arises from the bifurcation of the brachial one half inch below the bend of the elbow. The "tabatiere anatomique" of Cloquet or the anatomic snuff box is a triangular space whose base is the lower edge of the posterior annular ligament, its ulnar side is formed by the extensor secundi internodii pollicis tendon, the radial by the extensor ossis metacarpi and the extensor primi internodii pollicis muscle; the floor by the trapezium, scaphoid, their dorsal ligaments and the base of the first metacarpal bone.

The radial artery may be ligated in any of four places (Figs. 685-687).

1. In its upper third. Here an incision two inches long is made in the line of the vessel. The space between the pronator radii teres and the supinator longus muscles is sought out; the muscles are separated and the artery is exposed. At this point the radial nerve lies at some distance to the radial side of the artery.

2. In its middle third. An incision one and one-half inches long is made in the line of the artery. The inner border of the supinator longus muscle is sought for and the muscle is retracted outward. The artery will then be exposed lying upon the insertion of the pronator radii teres muscle with the radial nerve at its outer side.

3. In its lower third. An incision one and one half inches long is made in

the line of the vessel; the tissues are separated and the artery will be found lying between the tendons of the supinator longus and flexor carpi radialis muscles.

A small, superficial vein may overlie the artery. Injury to the superficial branch of the radial vein need not be feared.

4. At the back of the wrist. The radial artery turns to the back of the wrist at the base of the styloid process of the radius.

A vertical incision one inch long is made crossing the "anatomic snuff box" (Fig. 686) midway between the tendons which form its boundaries. The artery

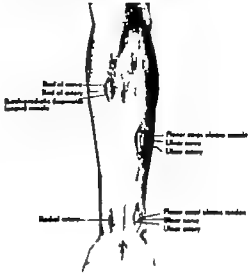


Fig. 685. Ligation of the radial and ulnar arteries. (Deaver, Applied Anatomy.)

will be found exposed deeply in this space, that is to say, at the point where it passes to the posterior surface of the hand. Bosca terms this "ligature in the palm-groove." In the palm-groove the lower boundary is the lower extremity of the radius and the artery lies just beneath the deep fascia.

As the radial artery is frequently ligated, it might be well to dwell a little further on the expression "anatomic snuff box," namely, the space bounded by the extensor ossis metacarpi pollicis, the extensor primi internodii pollicis to the outer side and the extensor secundi internodii pollicis to the inner side. The radial artery is in deep contact with the trapezium. Care must be taken of the tendon sheaths and also not to ligate one of the superficial veins mistaking it for the artery.

Collateral Circulation. The anterior and posterior interosseous artery; the carpal and palmar arches.

Ligation of the Ulnar Artery

Anatomic Considerations. (Fig. 685.) The ulnar is larger than the radial artery. It springs from the brachial about one-half inch below the bend of the elbow. It passes obliquely downward and inward beneath the superficial flexors of the forearm and reaches the ulnar side of the forearm somewhat above its middle. It passes along the radial side of the flexor carpi ulnaris to the radial side of the pisiform bone, terminating here in the superficial palmar arch. The vessel may be ligated at three positions (Fig. 685):

1. at the junction of the upper and middle thirds,

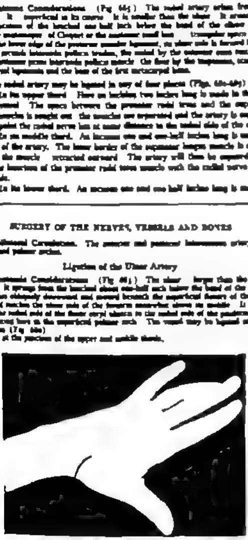


Fig. 686. Ligation of the radial artery in the "tabatière anatomique," which is formed by the line along the extensor tendons of the wrist. The dot indicates the position of the styloid process of the radius.

2. at the lower third,
3. at the wrist.

The ulnar artery differs from the radial in that it remains always on the anterior aspect of the forearm and descends to the front of the hand to form the superficial palmar arch. As previously stated the ulnar artery originates at the bifurcation of the brachial.

Ligation of the Upper Third. The arm is drawn away from the body and placed fully supinated upon a table. An incision two inches long is made in the line of the artery downward from the midpoint between the condyles of the humerus. The fascia is divided, the border of the pronator radii teres exposed, the muscle is drawn to the ulnar side together with the median nerve, and the artery is ligated just where it passes this muscle. Remember that the artery lies outside the ulnar nerve toward the center of the limb.

Ligation of the Middle Third. An incision three inches long is made in the line of the vessel. The muscles are exposed and separated, the artery will be

found lying upon the flexor profundus digitorum with the ulnar nerve lying just to its ulnar side.

3. Ligation of the Lower Third. An incision two inches long is made in the line of the vessel running upward from about one half inch above the pisiform bone. The artery will be found lying between the tendons of the flexor carpi ulnaris and flexor sublimis digitorum with the nerve on the ulnar side. The artery lies beneath the flexor carpi ulnaris tendon.

Precautions. The artery may vary in direction.

Collateral Circulation. By the anterior and posterior interosseous arteries and the carpal and palmar arches.

Ligation of the Palmar Arches

Step 1. Make an incision at the point of trauma about one or two inches in length depending upon conditions. The incision should run parallel with the nerves and tendons of the palm. All bleeding points are ligated.

Fig. 687. Temporary arrest of hemorrhage by compressing the aorta with the aid of an aseptic tourniquet of rubber tubing of appropriate size.

Step 2. Regardless of the site of injury the superficial palmar arch can be reached through an incision extending from the junction of the thenar eminence toward the ring finger. The deep palmar arch can be ligated opposite the middle of the base of the thumb. An incision is made beginning at the thenar eminence and is made to extend along the fold of the opponens pollicis toward the little finger.

Precautions. Make incisions in the long axis of the palm. Avoid injury to adjacent arteries, nerves and tendons.

Ligation of the Abdominal Aorta

The aorta divides at a point one half inch to the left of the midpoint of the line joining the highest points of the iliac crests (Fig. 687). To reach this important vessel the abdomen is opened and the intestines displaced to the
The peritoneum over the artery is divided; the inferior mesenteric vessel is

pared and retracted and the aorta is ligated. The vessel is more frequently ligated for hemorrhage than for amputation. Patients thus operated on are usually doomed. Recorded cases show that one patient survived for 48 days and another for 10 days.

Ligation of the Deep Epigastric Artery

Anatomic Considerations. The epigastric artery arises from the lower portion of the external iliac. It courses upward toward the umbilicus between the peritoneum and the transversalis fascia. It is also found at the inner border of the internal abdominal ring (see hernia operations).

This artery is ligated best by making an incision similar to Battle's appendix incision, opening the rectus sheath one-half inch inside the semilunar line, drawing the rectus muscle inward and tying the vessel as it crosses the semilunar fold of Douglas.

Ligation of the Common Iliac Artery

In certain grave pelvic conditions the operation is justifiable. The common iliac artery was ligated unsuccessfully by William Gibson in 1812, successfully by Valentine Mott in 1827. In five cases of transperitoneal ligation of the common iliac artery one death occurred in cases reported by Bryant.

If a line is drawn from the point of division of the abdominal aorta to the middle point of the line joining the anterior superior iliac spine and the symphysis pubis, the upper third of this line represents the course of the external iliac artery. The common iliac artery may be ligated either by the intraperitoneal or the extraperitoneal method, the former being the modern operation.

INTRAPERITONEAL METHOD

The patient is placed in the Trendelenburg position. Open the abdomen in the midline below the umbilicus. Make an incision about [illegible] inches long. Open the peritoneum and pack the intestines out of the way. A median incision is preferred because one thus avoids injuring the deep epigastric artery which is an important anastomotic branch.

Precautions. This procedure is attended with considerable danger. Injuries to the ureter or large veins must be guarded against. Great care must be exercised in dividing the posterior peritoneum. Do not mistake the external iliac artery for the common iliac trunk. It is well to remember that the sacral promontory is above the external iliac artery.

Collateral Circulation. The superficial and deep epigastric and the circumflex iliac anastomose with the lumbar, superior epigastric and the intercostal vessels, the iliolumbar and lateral sacral vessels anastomose with the lumbar and middle sacrals. The obturator, hemorrhoidal and vesical arteries anastomose with their opposite fellows.

The posterior peritoneum over the vessel is incised, the ureter identified and avoided and the artery ligated, care being taken to avoid the common iliac vein which lies behind the artery.

EXTRAPERITONEAL METHOD (A) ANTERIOR INCISION

This incision should be five to six inches long running for two inches parallel to and one-half inch above the outer half of Poupart's ligament and then turning slightly upward for three or four inches. All coats of the abdominal wall are di-

vided by splitting the muscle, until the extraperitoneal fat is reached. The peritoneum is then stripped up from the iliac fascia until the external iliac artery is seen, and this is followed up until the common iliac vessel is met which is then ligated.

(B) LATERAL INCISION

This extends through the tip of the twelfth rib to just above the iliac crest and then runs inward and forward to the anterior superior iliac spine. The patient must be well turned over upon the opposite side. The muscles are divided, the peritoneum stripped and the artery found and ligated as in the preceding method.

Ligation of the External Iliac Artery

Anatomic Considerations. The external iliac artery runs in the subperitoneal tissue along the brim of the true pelvis against the internal border of the

FIG. [illegible]. Sir Astley Cooper's incision for extra-peritoneal ligation of the external iliac artery. The dot at the right indicates the anterior superior iliac spine; the one in the middle appears over the symphysis pubis.

psoas muscle. Although it is easy to ligate this vessel intraperitoneally it is not necessary and in practice one of the extraperitoneal methods of reaching the artery is usually employed. The artery gives off no branches until just before reaching Poupart's ligament. The following are some of the methods in use.

SIR ASTLEY COOPER'S INCISION

The incision, four inches long, is made running parallel to the Poupart's ligament, one-half inch above it and extending to the inner side of its midpoint. (Fig. [illegible].) The intervening muscles are split and retracted upward and outward, the transversalis fascia is divided and the peritoneum drawn up until the artery is exposed. The epigastric and circumflex vessels must be carefully preserved and care must be exercised not to lift the vessel up with the peritoneum as well as not to damage the external iliac vein. The artery is ligated about one inch above Poupart's ligament.

ABERNETHY'S METHOD

An incision is made about four inches long, starting about one-half inch above and inside the anterior superior iliac spine, curving and running down a half-inch

above and parallel to the outer half of Poupart's ligament to its midpoint. The muscles and transversalis fascia are treated as in the preceding method. By this

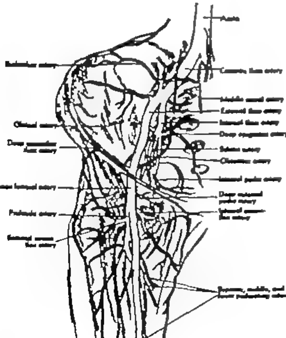


FIG. [illegible]. Collateral circulation after ligation of the external iliac artery. (Davis, Applied Anatomy.)

procedure the artery is ligated higher up than in Cooper's method and a better exposure is obtained.

In each of these methods the subperitoneal plane of cleavage is opened as far as along the artery which is then exposed. The aneurysm needle is then passed from within outward.

Precautions. Do not mistake the transversalis fascia for the peritoneum.

Collateral Circulation. (Fig. [illegible].) The superficial and deep epigastric arteries anastomose with the superior epigastric, lumbar and intercostal branches, the gluteal and sciatic with the circumflex and branches of the profunda femoris (crucial anastomosis), the obturator with the internal circumflex and the gluteal with the superficial and deep circumflex iliac and external circumflex branches.

Ligation of the Internal Iliac Artery

This artery extends from the sacroiliac synchondrosis to the upper border of the great sacrosciatic foramen. A four inch paramedian incision is made below the umbilicus, the peritoneum is opened and the intestines and omentum packed out of the way. The bifurcation of the common iliac artery is sought, the ureter pulled aside after the posterior peritoneum is incised and the artery is identified and ligated.

FIG. [illegible]. Lines useful in locating the gluteal and sciatic arteries. A, Posterior-superior iliac spine; B, Great trochanter; C, Outer part of tuberosity of ischium.

EXTRAPERITONEAL ROUTE

This operation was first performed by Stevens of Vera Cruz in 1812. The incision and method of exposure of the vessel are identical with those of ligating of the common iliac artery.

Precautions. The external iliac artery may be mistaken for the internal. Following the course of the vessel will dissipate the doubt.

Ligation of the Sciatic and Internal Pudic Arteries

The point where these vessels emerge from the pelvis is the junction of the distal and middle thirds of a line joining the posterior superior iliac spine to the outer part of the tuberosity of the ischium. To expose these vessels, an incision four inches long is made. The incision follows the direction of the fibers of the gluteus maximus muscle the center of the incision being at the above point. The muscle fibers are separated and the pyriformis muscle is exposed in the bottom of the wound. The distal edge of the pyriformis is isolated and traced up to the foramen where the artery will be found to each its exit. The internal pudic artery lies upon the tip of the ischial spine and is deeper and nearer to the midline than is the sciatic. (Fig. [illegible].)

Ligation of the Gluteal Artery

This vessel emerges from the pelvis at a point corresponding to the junction of the inner and middle thirds of a line joining the posterior superior iliac spine to the tip of the great trochanter (Fig. [illegible]). To expose it an incision four inches long running parallel to the fibers of the gluteus maximus and with the center of the incision at the above point is made. The fibers of the gluteus maximus are separated and the pyriformis muscle exposed beneath it. The upper

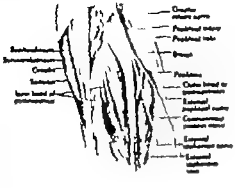


Fig. [illegible]. Dissection of right popliteal region, showing relations of vessels and nerves. (Cunningham's Textbook of Anatomy.)

border of the muscle and the gap between it and the gluteus medius muscle are exposed, the two muscles are then separated and the artery will then be found.

Ligation of the Popliteal Artery

Anatomic Considerations. (Fig. [illegible].) Keep in mind the intimate relations of the popliteal artery with the knee joint. The popliteal artery is continuous with the femoral. It begins at the junction of the middle and lower thirds of the thigh at the termination of Hunter's canal. It passes obliquely downward and outward to the lower border of the popliteal muscle.

Surface Marking. Beginning at the adductor tubercle, the vessel passes down, at first slightly outward then down to the middle of the popliteal space. The artery may be ligated in either the upper or lower part of the popliteal space down which it runs. (Figs. [illegible].)

LIGATION OF THE POPLITEAL ARTERY

UPPER PART OF THE POPLITEAL SPACE

The patient is placed on the abdomen. The limb is abducted. An incision is made four inches long, running along the outer border of the semimembranosus

muscle (Fig. [illegible]). The nerve is encountered, and when drawn aside, the vein will be found lying more deeply and internal to it. The vein should now be

Fig. [illegible]. Fig. [illegible].

Fig. [illegible]. Manual pressure to arrest bleeding from the popliteal artery . . . in the flexure of the thigh on the abdomen and the leg on the thigh.

Fig. [illegible]. Emergency compression of the popliteal artery.

Fig. [illegible]. Incision for exposure of the popliteal artery in the lower part of the popliteal space.

carefully isolated and pulled out of the way. The artery will be found at an inner side. Separate the sheath around it, ligate it.

LOWER PART OF THE POPLITEAL SPACE

An incision is made between the heads of the gastrocnemius. Avoid the external saphenous vein and internal popliteal nerve. Draw these aside, ligate the artery which is found lying on the bone.

Arteries of the Leg

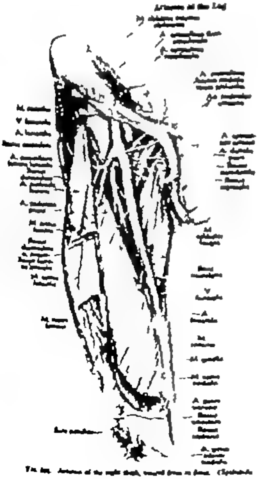


Fig. [illegible]. Arteries of the right thigh, viewed from in front. (Spalteholz.)

Caution. The tendon of the semitendinosus may be mistaken for the tendon of the semimembranosus muscle. Remember the possibility of two popliteal veins and rarely two popliteal arteries.

Ligation of the Femoral Artery

The femoral artery (Fig. [illegible]) is a continuation of the external iliac and enters the thigh anteriorly through the crural ring, lying between Poupart's ligament in front, Gimbernat's ligament internally, the iliac fascia on the outer side and

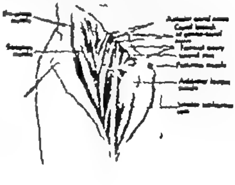


Fig. [illegible]. Superficial dissection of Scarpa's triangle, showing relations of femoral vessels. (Piersol, Human Anatomy.)

the horizontal ramus posteriorly. The lower landmark is behind the internal condyle of the femur.

Ligation of the Common Femoral Artery

The femoral artery may be ligated in three situations:

1. Just below Poupart's ligament (common femoral);
2. At the apex of Scarpa's triangle;
3. In Hunter's canal.

The most favorable situations are the apex of Scarpa's triangle and Hunter's canal (Figs. [illegible]).

In the first situation the artery is ligated just below Poupart's ligament, but the ligation is not often made in this place as the collateral circulation is not so good. It is usually done after ligation of the external iliac. With the thigh abducted, externally rotated and slightly flexed, an incision two inches long is made in the

FIG. 697. Digital compression of the femoral artery

FIG. 698. Ligating the femoral artery. The [illegible] the [illegible] of the adductor tubercle. The [illegible] A, [illegible] of the vessel in Hunter's canal; B, at the apex of Scarpa's triangle; C, below Poupart's ligament (common femoral)

[illegible] of the artery immediately below Poupart's ligament. The superficial veins and lymph nodes must be avoided and the sheath of the artery opened on its outer side.

Collateral Circulation. The obturator, internal pudic and circumflex iliac [illegible] respectively with the internal circumflex, external pudic, and external circumflex arteries.

AT THE APEX OF SCARPA'S TRIANGLE

Anatomic Considerations. (Fig. 698.) The saphenous vein runs along the inner side of this region. The femoral vein lies to the inner side. Branches of the internal cutaneous nerve lie in front, and the long saphenous nerve is to the outer side of the femoral artery.

The position of the limb is the same as in the preceding procedure. An incision about four inches long is made along the inner border of the sartorius muscle; divide the tissues down to the fascia lata; draw the sartorius muscle outward; feel for the pulsations of the vessel, which may often be seen. Open the fascia lata and the sheath of the vessel carefully. Ligate.

Collateral Circulation. As above, mostly through the profunda femoris and its branches.

Ligation of the Femoral Artery in Hunter's Canal

[illegible]

Hunter's canal begins at the apex of Scarpa's triangle.

With the limb placed in the same position as before, an incision three inches long is made in the line of the artery at the center of the thigh. The sartorius muscle is exposed, the fascia forming the roof of the canal is incised and the artery exposed. The wall of Hunter's canal is divided quite close to the adductor tendon. The femoral vein is situated posteriorly to the artery; the long saphenous nerve crosses the artery from without inward. The nerve to the vastus internus lies to the outside of the artery.

Caution. Do not mistake the sartorius muscle for other muscles. (Obesity [illegible] may be [illegible].) Enlarged lymph nodes lying on the sheath of the vessel may be mistaken for the vessel itself—the latter is below, the former in front of the fascia lata. Do not mistake the tendon of the adductor [illegible] for that of the [illegible]. [illegible] anastomoses. Follow their course for identification. [illegible] may be [illegible] or its position may be anomalous.

Ligation of the Profunda Femoris and the External Circumflex Arteries

Anatomic Points. The profunda femoris usually springs from the common trunk one or two inches below Poupart's ligament. It may arise above or lower below Poupart's ligament. It arises from the outer and posterior surface of the common femoral, it courses slightly outward, downward and inward, passing behind the superficial femoral.

Both the profunda femoris and the circumflex arteries may be reached and ligated through a vertical incision such as is made for exposing the common femoral (vide supra). Look for it at the outer side of the common femoral.

Ligation of the Posterior Tibial Artery

The posterior tibial artery may be ligated in three places.

The popliteal artery, on reaching the arch of the soleus, divides into the posterior and anterior tibial arteries. The posterior tibial continues under the soleus in the same direction as the main trunk and after a course of about one and one half inches gives off a large branch—the peroneal artery.

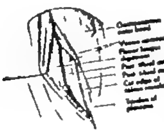


FIG. 699. Dissection of back of right leg, showing relations of posterior tibial vessels and nerve. [illegible] and soleus cut and drawn aside. [illegible] Human Anatomy.

Ligation of the Posterior Tibial Artery in Its Middle Third

Step 1. Place the patient on his back. Flex the leg on the thigh and the thigh on the pelvis. Rotate the thigh outward so that the leg will lie on the outer side.

Step [illegible]. Make an incision along a linear guide to the operation which [illegible] by a line located three-quarters of an inch behind the internal border of the tibia at the middle and lower thirds of the leg (Figs. 699-700). Divide the deep fascia; [illegible] the inner border of the gastrocnemius, beneath which are found the fibers of the soleus; this is divided longitudinally and its fibers are separated.

Step 3. Make an opening through the aponeurosis about an inch and one-half from the border of the tibia; the opening should be of sufficient size to expose the artery, its accompanying veins and the posterior tibial nerve. Isolate the

artery from its veins, displace the nerve outward. Ligate the artery from without inward.

Precautions. Do not mistake the gastrocnemius for the soleus. The posterior tibial artery may be double, rudimentary or absent. If the veins are [illegible] [illegible] with the artery, ligate them together.

Ligation of the Posterior Tibial Artery in Its Lower Third

The position of the limb is the same as before (Figs. 700, 701). Make an incision two inches long, parallel to and running between the adjacent margins of

FIG. 700. FIG. 701.

FIG. 700. Incisions for exposure of the posterior tibial artery. [illegible] the [illegible] the vessel in the middle and lower thirds of the leg and behind the internal malleolus.

FIG. 701. Incisions for ligation of the posterior tibial artery (A, B and C) [illegible] [illegible] of the leg [illegible] the tendo Achillis and inner border of the tibia [illegible] part of the internal annular ligament. The vessels are seen lying on the flexor longus digitorum, the nerve being situated behind and externally.

the tibia and the tendo Achillis. If the latter cannot be palpated, the incision should be a half inch behind the inner border of the tibia. Divide the skin and fascia in the usual manner; separate the borders of the wound. Divide the aponeurosis which binds down the deep layers of muscles about an inch from the internal border of the tibia; push aside the fat. The vessel will be found with its nerve and veins at the outer border of the flexor longus digitorum. Draw the nerve outward; separate the veins or ligate them together with the artery from within outward.

Precautions. Avoid the internal (great) saphenous vein. This is also to be observed in ligating the artery in its middle third. Keep in mind that the vessel lies on the deep muscles on the posterior surface of the tibia. The fat in front of the tendo Achillis may cause one to lose the way to the artery if not carefully looked for.

Ligation of the Posterior Tibial Artery Between the Os Calcis and the Internal Malleolus

Step 1. Flex the knee. The surgeon stands on the opposite side of the table facing the inner aspect of the limb.

Step 2. Make a curved incision, about three inches in length, with the concavity uppermost and the center at a point midway between the inner malleolus and the tuberosity of the os calcis. Divide the fascia and internal annular (laciniate) ligament over a grooved director. This precaution should not be neglected since the artery lies immediately beneath that ligament.

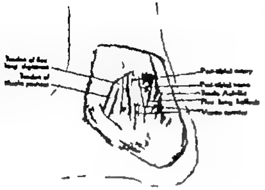


Fig. 302. Dissection of inner side of right ankle, showing relations of tendons, vessels and nerves as they pass between calcaneus and internal malleolus. (Partial [illegible] Anatomy.)

Ligate the vessel after having separated it from the veins, [illegible] without [illegible] (Fig. 302).

Collateral Circulation. Muscular and other branches of the peroneal and anterior tibial vessels.

Ligation of the Anterior Tibial Artery

The anterior tibial artery may be ligated in three places:

1. In its upper third.
2. In its middle third.
3. In its lower third.

Anatomic Considerations. (Fig. 303.) The anterior tibial artery arises from the popliteal just below the lower border of the popliteus muscle. It passes forward between the bones of the leg above the interosseous membrane, then downward on the anterior surface of that membrane to the ankle-joint where it becomes the dorsalis pedis artery.

Surface Marking. (Fig. 304.) A line drawn from a point midway between

the head of the fibula and the outer tuberosity of the tibia to a point midway between the two malleoli.

1. In its upper third. In this situation the operation is tedious and difficult. The artery is situated here very deeply between the tibialis anterior and the extensor longus digitorum muscles. An incision four inches long is made in the line of the artery. The intermuscular space between the tibialis anticus and the extensor communis digitorum muscles is identified and the muscles are separated. The anterior tibial artery will be found lying deeply upon the interosseous membrane with the nerve on its outer side and each a vein on both sides. To the outer side of the vessel lies the extensor longus digitorum, above and lower down the extensor longus hallucis. (Fig. 304 D.)

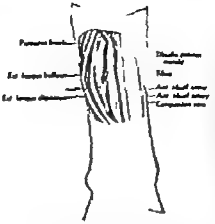


Fig. 303

Fig. 304

Fig. 303. Dissection of middle third of right leg, showing relations of anterior tibial vessels and nerve, anterior muscles [illegible]. (Partial [illegible] Anatomy.)
Fig. 304. Outline of incisions for ligating the anterior tibial and peroneal arteries.

2. In its middle third. (Fig. 304 F.) An incision three inches long is made along the line of the artery. The intermuscular space as above mentioned is again found. Upon separating the muscles the extensor longus hallucis is found and pushed aside. The artery will be found lying upon this with the nerve lying in front of it.

3. In its lower third. (Fig. 304 F.) An incision three inches long is made in the line of the artery ending just about two finger breadths above the line of the ankle joint. The artery will be found lying between the tendons of the tibialis anticus and extensor hallucis muscles and rather under cover of the latter, with the nerve on the outer side.

In ligating the anterior tibial artery it may be necessary to widen the intermuscular space which has been referred to. To do this it is best to introduce the large ends of two retractors transversely and back to back at the middle of the

opening, first turn them at right angles and pull one upward and the other downward. A quadrangular space is thus formed and in this space the nerve is first noticed, then the artery and its accompanying veins.

Collateral Circulation. This is formed by the muscular and other branches of the posterior tibial and peroneal arteries.

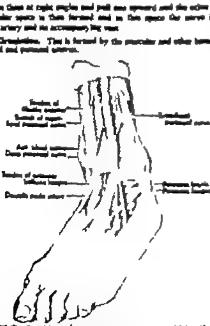


Fig. 305. Dissection showing relations of vessels and nerves [illegible] of left ankle [illegible] of [illegible] [illegible] plate. (Partial [illegible] Anatomy.)

Precautions. Do not mistake the head of the tibia for that of the fibula, the latter is situated more posteriorly and sometimes the more external bony prominence is the [illegible]. The anterior tibial artery may be rudimentary or absent. It may be situated more superficially than usual. Do not persist in separating the [illegible] veins, they usually will not [illegible] them together with the artery. The chief difficulty in the upper third is the identification of the proper septum. In the middle third the chief source of error is missing the septum between the tibialis anticus (anterior) and the extensor hallucis longus.

Ligation of the Peroneal Artery

This ligation is performed in exactly the same way as that of the posterior tibial artery.

Ligation of the Dorsalis Pedis Artery

Anatomic Considerations. (Fig. 305.) The dorsalis pedis artery is a continuation of the anterior tibial artery. It begins at the ankle and continues downward

between the metatarsal bones of the leg and second toe passing through the interosseous space into the sole of the foot. It lies between the tendon of the extensor hallucis longus internally and the innermost tendon of the extensor digitorum longus externally between which and the artery the anterior tibial (deep peroneal) nerve is situated.

For ligating the dorsalis pedis artery the foot is flexed plantarwise. An incision is made one and one-half inches long ending at the posterior extremity of the first interosseous space on back below the ankle (Fig. 306). The artery will be lying between the tendons of the extensor longus hallucis on the inner side and the innermost tendon of the extensor longus digitorum on the outer side. The innermost tendon of the extensor brevis digitorum may have to be pulled aside.

Fig. 306. Incision for exposing the dorsalis pedis artery. The [illegible] is [illegible] between the two malleoli [illegible] corresponds to the inner end of the first interosseous space. The dotted line indicates the [illegible] course of the artery. The [illegible] and [illegible] the [illegible] for the [illegible] of the artery [illegible].

Dronsfield's Method of Dealing with Uncontrollable Hemorrhage

During the Civil War when the usual method of controlling profuse hemorrhage was to bleed extensively, Dronsfield developed a method of withdrawing blood from the general circulation (sequestering) without loss to the body; it could then be returned gradually when the hemorrhage was controlled. It is still of great value in profuse bleeding when it is impossible to reach the bleeding points, i.e., large hemorrhages from the lungs, stomach and bowels, and possibly uterine hemorrhages.

Dronsfield applied bandages to the limbs with circular pressure to the upper parts of the arms and thighs, tight enough to check superficial venous circulation without affecting the deeper arterial inflow of blood. When hemorrhage has ceased the bandages are removed. If they must be left in place for a long time, it is wise to release them one at a time temporarily at fifteen to thirty minute intervals.

In a personal communication, Dr J F Baldwin of Columbus, Ohio, recommends the method and states that "so far as I can recall I have never had any unfortunate results but have quite uniformly accomplished the desired end."

OPERATIONS FOR PULSATING TUMORS (ANEURYSM)

CIRSOID ANEURYSM

This is a condition in which a number of dilated arteries, held together by connective tissue, form a tumor which is the equivalent of a venous varicosity. It is most common on the scalp.

According to Raymond W McNealy a standard procedure for moderately well-advanced cirsoid aneurysm of the scalp might include (Fig

"1. Preliminary ligation of the external carotid. If the frontal branch were involved and the patient below fifty years of age, partial or complete occlusion of the common carotid would become necessary.

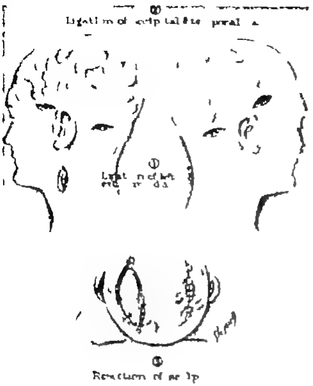


Fig. 727 Cirsoid aneurysm (courtesy of Dr R. W. McNealy)

"2. This might be followed, within a few days to a week, by independent ligature of the secondary trunks involved, such as the temporal, occipital and auricular arteries.

3. A short time later the main vessels may be ligated at the edge of the mass.

4. These procedures will usually have reduced the tumor-mass to such an extent that it then becomes feasible to extirpate completely that portion containing the abnormal arteriovenous communications. In the extirpation the same plan of treatment is followed.

TRUE ANEURYSM

Palliative Measures (General, Medical, Dietetic)

Valsalva counseled rest in bed, bleeding, diet to a point short of starvation.

Tufnell advised lowering of blood pressure by diet and rest.

Lancereaux practiced injection of gelatin at some indifferent point.

Dastre and Floresco showed (1896) that intravenous injection of gelatin increases the coagulability of the blood.

Lancereaux and Paulesco at a later date verified the same observations with gelatin injected at some indifferent point.

Carnot showed that the application of gelatin to a wound arrests bleeding.

Pressure by tourniquet: Saporta, Lister, Tufnell.

Tests Prior to Operative Treatment

This has to be resorted to in the majority of cases. When an aneurysm threatens to rupture, operation of one sort or another is immediately indicated—an emergency operation has to be performed. The condition of the collaterals in case of aneurysm of an extremity should be determined. If these are competent, operate without delay. If incompetent develop them. Matas lists the following plan to test the efficiency of collateral circulation:

1. The Sign of Quenu and Muret. To elicit this, the main artery of the affected limb is compressed and, while compression is maintained, a puncture is made at the periphery. If no bleeding follows the collaterals are regarded as insufficient. This test Matas rejects.

2. The Sign of Delbet. When an aneurysm forms on a main artery it is often found that the pulse below it disappears abruptly or gradually. When, in spite of absent pulse below the aneurysm, the nutrition of the part is well preserved, the collaterals are competent. Matas regards this sign as most valuable.

3. The Sign of Henle and Coenen. This sign becomes manifest only during an operation. If the blood is seen to spurt from the peripheral lumen of the aneurysm when the proximal end is compressed the collaterals are competent.

4. The Signs of Von Frisch. These signs can only be made manifest during operation.

(a) When pressure is applied to the proximal side of an aneurysm the peripheral part of the limb retains life.

(b) The sign of Henle and Coenen.

(c) When the main vein is compressed venous stasis arises below.

5. Korotkow's[*] Test. This is made by estimating blood pressure in the periphery while the main arterial trunk above the aneurysm is compressed. If the blood-pressure is fairly high the collaterals are competent.

6. Pachon's Test. This is also a blood pressure test made by means of an oscillometer.

Jour. Am. Med. Assn., 1908.

7. The Test of Tuffier and Heitz. If the main artery and vein are compressed in the lower extremity for example, the veins of the foot will swell only if a considerable amount of blood is taken to the periphery by the collaterals.

8. Stewart's Test. In this test the amount of blood passing through a part in a definite time is estimated by a calorimeter.

9. The hyperemic reaction of Moschcowitz. This test is applied to an extremity if the main artery can be compressed. The limb is elevated. An Esmarch bandage is applied from the periphery to the lower border of the aneurysm. An elastic compressor is applied to the main artery above the aneurysm to cut off all pulse below. After compression has been acting from 6 to 10 minutes the elastic bandage is removed while the compressor is still in place. At once a flush of hyperemia appears below the compressor and descends the limb quickly. Even when the collaterals are competent the digits remain of a waxy hue for some seconds. The longer the time required for the digits to become hyperemic the poorer is the collateral circulation. When the collaterals are impaired 10 minutes or more are required. In cases of great impairment 30 to 40 minutes may be necessary.

If the collaterals are found insufficient they may be reactivated by pressure exerted upon the artery above the aneurysm. The pressure should not entirely cut off the circulation; several such séances a day should be held until collateral circulation is improved, or it becomes evident that it is not going to do so.

Operations by Ligature and Suture

Antyllus, a Roman successor to Galen practiced ligature in the third century A.D. Matas named Antyllus' procedure Aneurysmectomy (Fig. 728 A).

Step 1. Apply an Esmarch constrictor.

Step 2. Make a linear incision over the aneurysmal sac along the course of the affected artery. The incision is carried far enough to expose the artery at its entrance and exit from the sac. Retract the veins. Ligate the artery close to its entrance and exit to the aneurysm. Make a small incision into the aneurysmal sac and evacuate its contents.

Philagrius (c. 400) performed aneurysmectomy (extirpation of the aneurysmal sac) after ligature of the vessels.

Preliminary hemostasis is essential in these operations.

Proximal Ligature (Anel's Method)

In 1710, Anel of Toulouse, suggested that the artery be ligated above the sac, so close to the sac that there are no anastomotic branches between it and the ligature. Anel's operation shuts off the circulation at once thus decreasing the size of the aneurysmal sac (Fig. 728 B).

Desault-Hunter Operation

This operation was described by John Hunter and performed by him in January 1786, although Desault ligated the artery proximally in June, 1785. Hunter's thought was to place the ligature at some distance from the sac, in a normal segment of the artery (Fig. 728 C). In such instances, the circulation is not cut off permanently, but its force and frequency are diminished sufficiently to favor formation of a clot within the aneurysmal sac.

Distal Ligature (Brasdor-Deschamps Operation)

In cases where proximal ligature was too dangerous or impossible, distal ligature was resorted to. Brasdor in 1790 suggested this procedure, but this was first carried out by Deschamps in 1798 and by Sir Astley Cooper about the same time. Distal ligation obstructs the outflow of blood, the collateral branches above the aneurysm enlarge, the current of blood is gradually diverted and a clot may

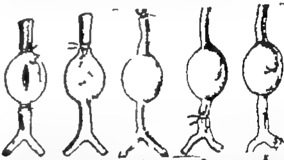


Fig. 728. Ligature of aneurysm. A. Antyllus' method of treating an aneurysm. Proximal and distal portions of the artery close to the aneurysmal sac. The sac is opened and its contents evacuated. B. Anel's method of treating aneurysm. The artery is ligated proximal to the aneurysm, close to the sac. C. Desault and Hunter: method of proximal ligature of the artery at some distance from the aneurysmal sac. D. Brasdor: operation of distal ligature of the artery close to the aneurysmal sac. E. Wardrop's operation. The artery is ligated distally at some distance from the sac. Wardrop applied the ligature on a main branch after it had been given off from the parent trunk.

form within the aneurysm (Fig. 728 D). Distal ligation is resorted to in some aneurysms of the aorta, the iliac, innominate, carotid and subclavian arteries. John Chalmers DaCosta recorded two notable results by ligating the common carotid and subclavian artery on the right side in aneurysm of the innominate artery, with one patient living and well over five years after the operation.

Wardrop's Operation

James Wardrop of London in 1825 ligated the main branch of the parent vessel at some distance from the sac. In 1809 Wardrop successfully ligated the carotid distally for carotid aneurysm and in 1827 for subclavian aneurysm (Fig. 728 E). The circulation in Wardrop's procedure is but partially arrested.

Halsted in 1906 suggested a method of treating aneurysm by proximal or distal application of an aluminum band to reduce the caliber of the artery. "The bands are of 30 to 36 sheet-metal gauge thickness. Halsted devised a set of instruments for the application of the bands to the vessel. Experience has shown the method to be ineffective" (Wayne Babcock).

Surg. Gyn. & Obst., June, 1909.

Objections to Ligation Procedures. Matas said, "Complete arrest of ... are observed in all methods of ligation. The aneurysm may recur after a number of years (Delbet, Matas). The presence of the sac and its ... branches may cause pressure symptoms in peripheral nerves paralysis, peripheral neuralgia, edema, ... gangrene, trophic ulcers, etc.

Aneurysmorrhaphy—Matas' Operation

Matas' operations are performed from within the aneurysmal sac. Various types of operation are used to suit the lesion presenting themselves.

Obliterative Endo-Aneurysmorrhaphy Without Vesselsorrhaphy

This procedure is suited for fusiform aneurysms. In the words of Matas: "No attempt is made to reconstruct the parent artery (arterioplasty) and the arterial orifices are simply obliterated by suture."

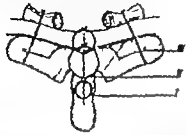


Fig. ... Diagram of method of obliterating the sac in obliterative endo-aneurysmorrhaphy ... (after Matas.)

Step 1. Apply tourniquet or elastic constrictor. Make a free incision parallel to the long axis of the aneurysm down to the sac. Avoid injury to important adjacent structures.

Step 2. Incise the sac freely making all its parts accessible to touch and sight. Clear out the contents of the sac (Figs. ...). Retract its walls so that all orifices opening into it are rendered visible. If there are two main orifices connected by a groove of more or less normal arterial wall the aneurysm is of the fusiform variety—and therefore, suitable for the obliterative operation. If the two openings are connected by a groove of more or less healthy arterial wall, so that the groove is sufficiently wide and composed of sufficiently good tissue to permit reconstruction of the artery (restorative endo-aneurysmorrhaphy). If the groove is narrow and its tissue looks suspicious the obliterative operation is imperative. If only one opening is present in the sac wall and the aneurysm is sacculated, reconstruction may be done.

Step 3. Select a curved needle without cutting edge; thread it with catgut. Close all the orifices entering the sac. Another similar suture obliterates the deeper portions of the sac, covering all the lateral arterial branches. Lembert infolding suture. Remove the constrictor. If bleeding is observed at some point, additional sutures are inserted. If not, the wall of the sac, plus skin, are turned inward and fixed with sutures. It is of utmost importance not to separate the sac from its surroundings because its walls are usually poorly nourished and sloughing might result from devascularizing this point. Apply drainage.

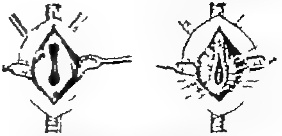


Fig. ... Matas' endo-aneurysmorrhaphy, obliterative suture. The illustration depicts the method of passing the sutures, which are interrupted ... A branch arising ... from the aneurysmal sac is shown ...

Restorative Endo-Aneurysmorrhaphy (Matas)

This operation is only applicable to saccular aneurysms with a single opening into the parent artery already reduced to a formed vessel, and in which the closure of the fundus opening can be accomplished "with the greatest facility and simplicity."

Operation

Steps 1 and 2 are the same as in the preceding operation. The single opening is closed by a line of Lembert catgut sutures or of continued silk sutures carried on a very fine curved needle (Figs. ...).

Reconstructive Endo-Aneurysmorrhaphy (Matas)

This procedure is useful in fusiform aneurysms when the openings of the parent vessel into the sac are not too widely separated and there exists sufficient normal arterial wall for the reconstruction of a channel for the flow of blood. A catheter is used as a scaffolding over which the arterial wall is reconstructed. The ends of a piece of soft rubber catheter are introduced into the two arterial openings. The catheter is removed after the suture lines have been introduced. The remainder of the sac is utilized to reinforce the suture line. Figure 713 illustrates the steps in the management of a popliteal aneurysm by obliterative aneurysmorrhaphy method of Matas.

ANEURYSMECTOMY-ARTERIORRHAPHY

When the aneurysm can be excised and the ends of the vessel portions of sufficient length sutured, this should, when indicated, be practiced.

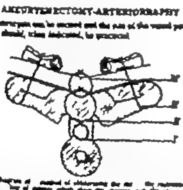


Fig. ... Diagram of method of obliterating the sac ... (after Matas.)

DIFFUSE TRAUMATIC ANEURYSM (PULSATING HEMATOMA)

In this condition there is no true or complete aneurysmal sac. It is caused by an escape of blood from an injured vessel into the surrounding tissues (stab or bullet wounds). The spurious sac here is composed of clotted blood, compressed muscle fibers and inflammatory exudate. Secondary hemorrhage is frequent.

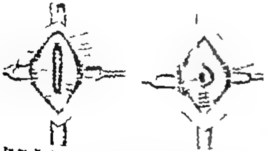


Fig. ... Matas' reconstructive method ... treating an aneurysm of a large artery ...

If bleeding is dangerous the treatment may become one of the emergency operations, otherwise delay is permissible. Apply tourniquet for additional efficiency. If operation is decided upon, apply an Esmarch constrictor above the aneurysm. Incise the aneurysmal sac and turn out the blood clots. If the wound in the artery is small, suture it. If suturing the artery threatens to result in excessive narrowing, abandon this procedure and resort to:

1. resection of a portion of the damaged artery and perform an end-to-end suture, or
2. interpose a piece of resected vein if the gap is too large although this is not often successful. (Circular Anastomosis—Carrel, Lexer). Matas and Delorme condemn this procedure. Jager, Bier and von Eiselsberg use it. Or do
3. Matas Operation or
4. an Antyllus Operation
5. In grave cases resort to amputation.

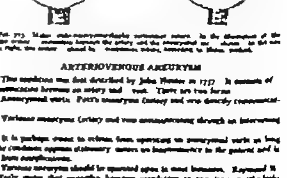


Fig. 713. Matas' endo-aneurysmorrhaphy, restorative suture. In the illustration at the left, the orifice ... communicating between the artery and the aneurysmal sac is shown. In the one to the right, the suture ... (after Matas, modified.)

ARTERIOVENOUS ANEURYSM

This condition was first described by John Hunter in 1757. It consists of communication between an artery and a vein. There are two forms:

1. Aneurysmal varix. Pott's aneurysm (artery and vein directly communicating).
2. Varicose aneurysm (artery and vein communicating through an intervening sac).

It is perhaps wisest to refrain from operating on aneurysmal varix as long as the condition appears stationary, causes no inconvenience to the patient and is free from complications.

Varicose aneurysm should be operated upon in most instances. Raymond H. McNeely states that operation becomes mandatory at any time, particularly, however when there are signs of

progressive enlargement of the sac or hematoma,

2. venous stasis which gives rise to increasing varicosities; these are usually of greatest significance in the lower extremity,

3. trophic disturbances which impair or imperil the vitality of the part,

4. intractable pain or paralysis arising from nerve involvement,

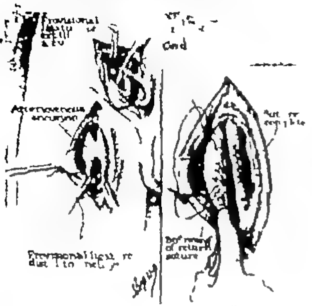


Fig. 714. Arteriovenous aneurysm. (Courtesy of Dr. R. W. McNealy.)

5. cardiac manifestations which signal impending or actual myocardial damage or

6. special complications such as [illegible], hemoptysis or convulsions.

Operative Measures

Immediate repair in the absence of infection.

Treatment consists of ligation of the afferent and efferent vessels with or without excision of the sac. This, of course, applies to vessels of lesser magnitude. In important vessels, ligation of the vein carries with it the danger of gangrene. Therefore, preservation of the vein in arteriovenous aneurysm plays a [illegible] role. Careful selection of operation to suit special instances is of utmost importance.

LIGATION

Anel-Hunter's method is, on the whole, unsatisfactory.

Preliminary ligation of the main trunk has been practiced with success by McNealy. In 1922 McNealy and Lichtenstein used a special method for applying autogenous fascial bands thus obviating the danger of the suture cutting through.

[illegible] reported success from ligation of the [illegible]. It is [illegible] when the [illegible] is large. [illegible] of the fascia and [illegible] of the proximal openings in the artery and vein are recommended by McNealy (Fig. 714).

OTHER METHODS OF TREATMENT OF ANEURYSM

Ligation of the principal vascular trunks.

Compression.

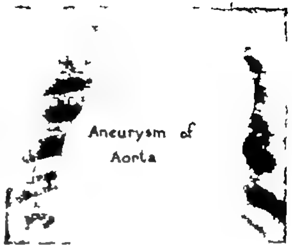


Fig. 715. Aneurysm of the aorta.

3. Introduction of foreign bodies into the aneurysmal sac (Moore-Colt).

4. Electrolysis (Corradi).

5. Acupuncture (Sir William Macewen).

6. Perianeurysmal sympathectomy (Gordon).

7. Amputation is indicated in

(a) Gangrene.

(b) Suppuration of aneurysm or its diffusion.

(c) Uncontrollable secondary hemorrhage.

ANEURYSM OF SPECIAL ARTERIES

Aneurysm of the Thoracic Aorta

This condition is treated mainly by medical measures. When the aneurysm projects in front, the introduction of gold wire or Colt apparatus is attended with some success (Figs. 715, 716, 717).

In aneurysm of the ascending arch of the aorta, ligation of the right carotid and right subclavian or of the left carotid artery alone should be done.

Fig. 716 Fig. 717

Fig. 716. Saccular aneurysm of arch of aorta. See next Fig. 717.

Fig. 717. Same as preceding. Operation by wiring. Recovery. (Courtesy of Dr. R. W. McNealy.)

Aneurysm of the Innominate Artery

Rest and at times potassium iodide in large doses are of value. Distal ligation may be used. Innominate aneurysm is very frequently associated with aneurysm of the arch of the aorta.

Aneurysm of the Common Carotid Artery

Ligation of the common carotid above or below the omohyoid muscle may be tried. If the aneurysm is near the root of the neck, Brasdor's operation is the procedure of choice (Fig. 718).

Aneurysm of the External Carotid Artery

In suitable cases dissect the sac after ligating the branches that spring from it. If this fails ligation of the trunk of the external carotid is indicated. In other cases it is likely to follow ligation of the common carotid (Fig. 719).

Aneurysm of the Right Temporal Artery

Figure 719 depicts aneurysm of the right temporal artery.

Aneurysm of the Internal Carotid Artery

(Extra Cranial Portion)

Ligation of the Common Carotid.

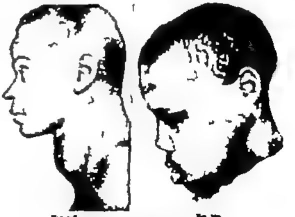


Fig. 718 Fig. 719

Fig. 718. Aneurysm of the common carotid.

Fig. 719. Arteriovenous aneurysm of the temporal vessel with local gangrene. (Courtesy of Dr. R. W. McNealy.)

Aneurysm of the Orbit

Ligation of the Internal Carotid.

Aneurysm of the Subclavian Artery

This form of aneurysm is difficult to treat. Treatment: Matas Operation. Ligation of the Innominate Trunk (Hunter's method).

Aneurysm of the Axillary Artery

Compression (digital); ligation of the subclavian (third portion) (Fig. 720).

the Brachial Artery

Extirpation (Fig.

Medical comp

Iliac and Inguinal Aneurysm

[illegible] proximal ligation

Popliteal Aneurysm

[illegible] Aneurysmorrhaphy of either type [illegible]

Femoral Aneurysm

Compression. [illegible]

Comment. The analytical student will find some food for thought when analyzing what has been said about the various operations for

Fig. [illegible] Right temporal aneurysm. (Courtesy of Dr. R. W. McNealy)

[illegible]

[illegible]

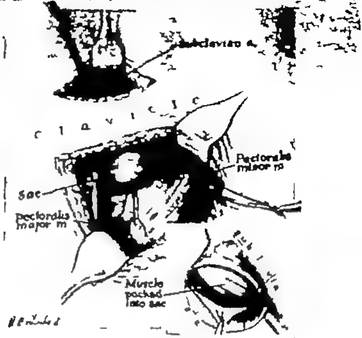


Fig. [illegible] Aneurysm left axillary artery. [illegible] (Courtesy Dr. R. W. McNealy)

[illegible]

[illegible]

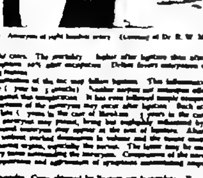


Fig. [illegible] Aneurysm of right brachial artery. (Courtesy of Dr. R. W. McNealy)

[illegible]

[illegible]

Fig. [illegible] Aneurysm of the popliteal artery. (Courtesy of Dr. R. W. McNealy)

[illegible]

[illegible]

Fig. [illegible] Aneurysm of the popliteal artery. (Courtesy of Dr. R. W. McNealy.)

[illegible]

Fig. [illegible] Aneurysm of the femoral artery. (Courtesy of Dr. R. W. McNealy.)

[illegible]

[illegible]

OPERATIONS ON THE VEINS

VENESECTION

(PHLEBOTOMY, BLOODLETTING)

[illegible]

Fig. [illegible] Superficial structures [illegible]

[illegible]

[illegible]

EMBOLISM

[illegible]

Fig. [illegible] Venesection.

[illegible]

VARICOSE VEINS (VARIX-PHLEBECTASIA)

Varicose veins are usually encountered in the lower extremities. Defective heart valves, pressure occasioned by pregnancy, tumors, tight corsets or garters as well as occupations demanding constant standing in an erect position over considerable length of time and the type of shoes, as aptly depicted by Frederick Dyas, all contribute to the formation of varicose veins. Nevertheless the definite factors responsible for the enlargement and atrophy of the vein wall are not definitely understood.

Retarded circulation in affected veins is likely to result in phleboliths which are palpable under the skin. If the saphenous or femoral veins are involved,

Fig. 378. Phlebectomy.

there is danger of embolism from detached thrombus. The dilatations may be of fusiform or saccculated character. In the latter variety the vessel wall is likely to break followed by considerable hemorrhage.

The skin of the leg and foot tends to become infiltrated and inflamed. This is likely to cause any minor injury to become infected resulting in so-called "varicose ulcer." Varicosities affecting large areas of fine veins are much more annoying than those affecting large venous trunks. When large, deep-seated veins rupture, there is considerable swelling accompanied by ecchymosis. If they become inflamed but do not rupture, the surface area may become red, but with no ecchymosis. Thrombosis of the veins is indicated which may result in periphlebitis and abscess formation if infection supervenes.

All factors which tend to aggravate the condition should be removed before instituting local treatment for varicose veins. Temporary relief may be obtained

by elevating the affected limb. Elastic and flannel bandages are also useful. An elastic stocking which fits snugly gives more lasting effects.

Injection Treatment

Injection treatment of the blood vessels is not recent. Pravaz, in 1851, invented a syringe for injection of ferric-chloride into aneurysms. The obliterating action of mercuric-chloride solutions, and glucose when repeatedly injected into a vein is well known. Sicard, observing this action during the war following injections of [illegible], applied the method to varicose veins, first using sodium salicylate. Since then various solutions have been recommended.

The method, if it does not later prove disappointing, has many advantages over surgical work, particularly in that the patient is not incapacitated and can carry on his daily work undisturbed. No scars result and many small veins are treated which would not receive attention in surgical work. McPheeters, of Minneapolis, has reported 55,000 cases injected, with seven deaths (.0127 per cent). From the standpoint of recurrence, the injection method is 5 to 6 times as successful as the surgical. In either case the main saphenous vein must be obliterated.

The general pathology following injection, Sicard advises that substances chosen for injection be sclerosing and not thrombus forming chemicals.

Sicard describes three distinct phases which take place following injection: first, cloudy swelling of the endothelium extending to the outer coat of the vein; this results in the lumen being pinched off and the blood being forced out so the vein becomes narrower. This causes the flow of blood to slow up, thrombosis takes place and the second stage appears. The clot is firmly fastened to the vein wall so there is little danger from embolism. The vein with the clot becomes organized. Sicard calls this process "venitis" as opposed to phlebitis. This takes place in the vein and varies in accordance with the amount and type of solution used. In the smaller veins [illegible] the blood is forced out of the vein and no clot forms.

It has been shown in different instances that the bloodflow in large varicosities is slowly in the direction of the heart or stationary when the patient is lying down; when standing, it is toward the periphery. This might [illegible] why embolism does not often occur after injection and why the patient should be ambulatory following the treatment. McPheeters' figures show a mortality of only [illegible] per cent from pulmonary emboli.

The Trendelenburg test (which see) enables the surgeon to learn the direction of the blood flow in varicose veins. If the leg is raised, the veins permitted to empty and the patient stands quickly the veins will be noticed to fill from above. The constriction tests show that the leg fills slowly from below. When the veins are emptied, a tourniquet is placed around the thigh and the patient permitted to stand. The veins are noted to fill very slowly from below or hardly at all. Immediate filling takes place as soon as the constriction is removed. If the vein happens to fill rapidly before the constriction is removed, it denotes regurgitation from deep to superficial veins resulting from a dearth of competent valves in the perforating veins.

The treatment is easily given and causes the patient little discomfort. It should not be given to patients who have suffered recent phlebitis or those who

suffer from cardiorenal disease or any long-standing illness which has left the patient in run-down condition. Pregnancy is a contraindication for sclerosing injections.

The needles used should be very fine and sharp and should be inserted directly into the vein (Fig. 379). A tourniquet may be applied before the vein is entered and after it is emptied of blood the injection should be made and the point of insertion protected by a coating of collodion and a sterile gauze dressing lightly applied. The patient is not incapacitated by the procedure.

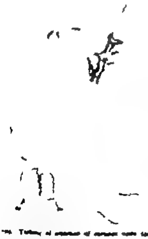


Fig. 379. Technic of injection of varicose veins (after [illegible])

A favorite solution used by many is salicylate of soda at 20 to 40 per cent solution using 3 to 10 cc at each sitting; this is followed by cramping pain of short duration and sometimes by muscular cramps which last a few minutes. The injection of Genevrier solution which consists of quinine hydrochloride, urethane and distilled water, produces although the veins involved may be tender for 24 hours. It is, however, considered superior to the salicylate of soda solution. Sodium morrhuate is preferred by many.

The puncture area for the injection treatment should be rendered sterile by the application of ether and iodine. Insert the needle at the lowest point of the vein, withdraw it a little so that a drop of blood flows backward through the needle; hold the needle in position for half a minute. Cover the point of puncture with gauze or cotton and insert the needle about two inches higher. When the injections have been completed, sponge the skin again with ether and pro-

tect the needle wounds with collodion. The treatments should be given about once a week.

The size and position of the involved veins govern the injection of the liquid. A swelling takes place on each side of the puncture which lasts a few days and the area injected may be slightly painful. Swelling of the foot and ankle may follow the injection of the large veins of the calf. Itching and discoloration may also follow for a short time.

The natural tendency of the patient toward developing varicose veins may result in the formation of new vessels; however, they very rarely recur in the region which has been injected.

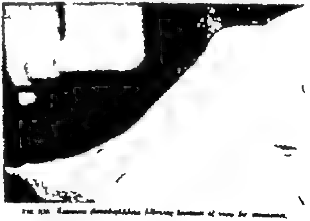


Fig. 380. Extensive [illegible] following injection of vein for varicosities.

The injection treatment also offers the advantage of permitting the patient to go about his work as usual.

Great care should be taken that the point of the needle does not slip out of the vein, thus directing the solution into the surrounding tissues. Such a slip may result in the sloughing of the tissues injected (Fig. 380). In cases where the varicose veins are complicated by eczema, dermatitis and edema, steps should be taken to reduce the blood content. The application of proper bandages which have been treated generously with Unna's paste is often effective. The limb should be maintained in an elevated position. When local improvement has been obtained, the injection treatment outlined above is undertaken.

Precautions. The following rules were formulated by Ronald Thornhill:

Don't forget the possibility of spontaneous [illegible].

Don't fail to inquire for a history of white swelling or phlebitis.

Don't inject a drop of solution unless sure that the point of the needle is in the lumen of the vein.

Don't inject with the patient in standing or sitting position.

Don't be tempted to inject compensatory varices.

Don't try to hurry the treatment by increasing the dose too rapidly.

Don't inject solutions of quinine during pregnancy or menstruation.

Don't proceed with the injection of quinine and urethane if the patient complains of pain.

Don't inject the floor of an ulcer.

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Trendelenburg test. Marked varicose veins.
Fig. [illegible] Trendelenburg test. First phase.

Don't, because an ampule has been opened, inject the whole of its contents.

Don't forget as the matter of dosage each vein is a law unto itself and therefore incline to under-dosage if in doubt.

Don't use a blunt needle.

Don't inject air bubbles into a vein.

II. Operative Treatment

The object of operative treatment of varicose veins is to transfer the circulation from the superficial veins to the deep veins. It therefore stands to reason that before such operation is undertaken the circulation in the deep veins must be unimpeded. It must also not be forgotten that superficial varicosities may be [illegible] method of "detour" from an obstructed vein. The Trendelenburg test depicted in Figs. 731, 732, 733, 734 permits the competence of the deep veins to be tested.

In cases of doubt, Mayo applies an elastic support to the affected limb for [illegible] week. If the patient feels relieved, it speaks for competency of the deeper veins.

Trendelenburg considered the fact that regurgitation of venous blood from the deep femoral vein into the long saphenous vein takes place resulting in varicose veins. On this basis the Trendelenburg operation was evolved which consists of doubly ligating and dividing the long saphenous vein close to the saphenous opening.

TRENDELENBURG'S OPERATION

Step 1. Local anesthesia (Fig. 735).

Step 2. Surround the upper part of the thigh with a constrictor sufficiently tight to cause superficial dilatation of the veins.

Fig. 733. Trendelenburg test, second phase. Superficial veins filled.

Step 3. Make a longitudinal incision about two inches long along the course of the vein at the junction of the middle and upper thirds of the thigh (Fig. [illegible]).

Step 4. Expose, isolate and ligate the long saphenous vein at the upper and lower angle of the wound. The portion of the vein situated between the two ligatures is excised. Suture the wound. Dress. Keep the limb at rest in an elevated position for a fortnight.

Fig. 734. Trendelenburg test, third phase. Deep veins competent.

[illegible] OPERATION

Step 1. Apply a tourniquet after emptying the veins as illustrated above. After outlining the veins to be excised, a longitudinal incision is made along the vein. Avoid cutting into the varicose vein. The incisions [illegible] carried out as shown in the illustration (Fig. [illegible]).

Step 2. Retract the skin, expose the main trunk of the vein, ligate it. Grasp the distal end with an artery forceps and divide it between two ligatures. While traction is made on the artery forceps, the varicose bundle is excised with scalpel or scissors. Collateral veins are doubly ligated and divided. Close the skin after hemostasis has been secured. Dress.

Note. The removal of varicose veins may be aided by using Mayo vein dissector (Fig. [illegible]). Babcock's acorn tipped, semi-stripping, [illegible] are not [illegible] in cases where the veins are adherent to the skin, fascia or scarred in nature.

Fig. [illegible] Local anesthesia for operation on varicose veins.

FRIEDEL'S OPERATION

In cases where there is a marked enlargement of the veins, where inflammation has supervened rendering excision of the veins difficult and hazardous, Friedel's procedure may prove of value. It is certainly worth considering in cases complicated by ulcer crura and marked inflammatory reactions.

Step [illegible] Ligate doubly and divide the long saphenous vein.

[illegible]p 2. Mark a spiral line with a scalpel encircling the affected limb above and below the involved region. The rings of the spiral should be rather close; the more the veins are divided the greater the chances are for cure (Fig. [illegible]).

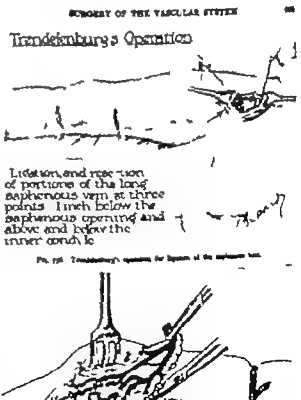


Fig. [illegible] Trendelenburg's operation for ligation of the saphenous vein.

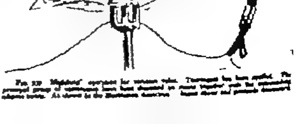


Fig. [illegible] "Mayo's" operation for varicose veins. Tourniquet has been applied. The proximal group of varicosities have been dissected [illegible] [illegible] above and [illegible] [illegible]. As shown in the illustration [illegible].

Step 3. Incise the structures along the outlined spiral to the deep fascia. Ligate the vessels as encountered, guided by proper retraction. In ulcerations, join the spirals above and below the ulcer by two vertical incisions. This will divide the veins coming from the ulcer.

Fig. 738. Mayo vein dissecting forceps.

Step 4. Pack the whole length of the wound. Let it heal by granulation.

Moreschi. Incisions are circular dividing the muscular fascia.

Rindfleisch. Incisions are similar but spiral.

TRENDELENBURG'S OPERATION

The rationale of this operation is based upon Trendelenburg's observation that varicosity of the long saphenous vein is due to incompetent valve action at its junction with the femoral—the weight of the blood column in the inferior cava bearing on the saphenous vein. In the femoral vein there exist valves below the junction of the two veins. The operation is performed as follows:

Step 1. Make an incision about an inch long from Poupart's ligament along the femoral vein.

Step 2. Expose the spot where the long saphenous vein empties into the femoral vein.

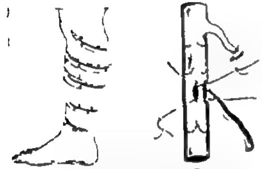
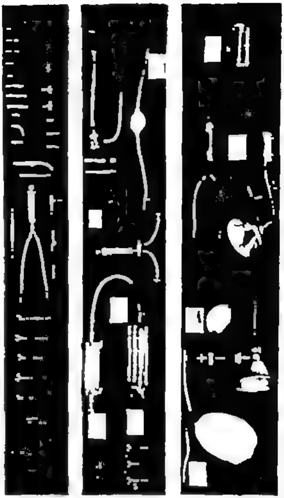


Fig. 739 Fig. 740

Fig. 739. Friedel's operation. Spiral incision of skin, subcutaneous tissue and superficial fascia. [illegible]

Fig. 740. [illegible] of the saphenous vein into the femoral vein. (After [illegible])

Step 3. Doubly ligate the saphenous as in the Trendelenburg operation and divide it. Ligate collaterals as encountered.



(Courtesy of [illegible] Company)

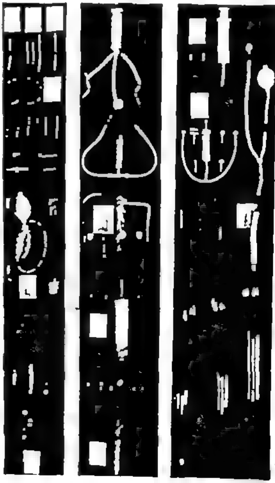
DEVELOPMENT OF INSTRUMENTS USED IN BLOOD TRANSFUSION

Figs. [illegible]

[illegible] A. D. The first attempt at transfusion of blood was made by [illegible], an English [illegible].

[illegible] A. D. James Blundell, an English [illegible]

[illegible]



Step 4. Do an end-to-end anastomosis between the lower end of the saphenous vein and the femoral vein by suturing the open end of the saphenous into an appropriate opening made into the side of the femoral. (Fig. 740.)

Comment. Only those who are expert in vascular surgery should attempt the operation.

BLOOD TRANSFUSION

Historical Notes. (Figs. 741-742-743.) The Book of the Wisdom of Solomon refers to blood transfusion. It is also referred to in the mythology of [illegible]. In Ovid the following line, "Ut replenis vacuas [illegible] [illegible] venas," is of definite significance in this connection. Villari's "Life of Savonarola" speaks of the transfusion practiced by a Jewish physician on Pope Innocent the Eighth in 1492. Lake or Lower about 1665, at Oxford University, transfused blood from one dog to another through the medium of a quill. Sir Christopher Wren and Archibald, about two years later, transfused a drunkard with sheep's blood. No fatal issue followed. In 1666 Dr. Coxe told Pepys of an experiment in animal (dog) blood transfusion. The Parliament of Paris issued an edict that no transfusion of blood can be done without the permission of the "Faculty of Medicine" of Paris. The method was ridiculed and attacked by its detractors and soon was suppressed. In 1835 Bishop introduced the use of defibrinated blood; the method proved dangerous. Transfusion was not recognized as a legitimate method until Blundell in 1824 proved its merit. In [illegible] Landois showed that animal serum was hemolytic to human blood. In 1890 [illegible] showed that the serum of a healthy man will prove hemolytic to a serum alien to it. This contribution was of great value in emphasizing that human serum alien to another serum is dangerous and may cause death. Von Bergmann pointed out that salt solution is just as efficacious as blood, the important point being to restore intracardiac and intravascular pressure and not the nutritive value of the blood. Nicholas Senn condemned transfusion as useless; in fact, blood transfusion was in abject disrepute until Crile in 1898 revived this great aid in medicine by the direct method of transfusion. Crile and Carrel showed that blood is superior to salt-solution. D'Agata of Montpellier devised the citrate method. Frequent reactions were the result. Modern practice consists of transfusing whole, typed blood.

At present many cases deemed inoperable may be brought to operability by means of blood transfusion.

Crile in 1906 has shown that when a patient is nearly dead or apparently so, the introduction of salt solution by a vein may overwhelm the heart and cause death. Crile, in such cases, counsels the introduction of salt solution and adrenalin through the carotid artery. The needle is promptly introduced into the artery toward the heart. If the heart begins to act, blood will appear in the tube and the administration of the fluid is discontinued. Blood-pressure in the coronary arteries may thus be reestablished.

DISEASES TRANSMITTED BY BLOOD TRANSFUSION

A survey of the literature, prepared by Harriet Hendrick under the auspices of the Committee on Blood Transfusion in the Hospitals of Chicago, to determine

Proceedings of the Institute of Medicine of Chicago, Vol. [illegible], No. [illegible], January [illegible], [illegible].

[illegible] A. D. [illegible] transfusion apparatus—a syringe made entirely of glass provided with a ground plunger and three-port connections, one for the donor, one for the cannula and one for recipient. Valve action is produced by rotating the plunger [illegible] [illegible] device provides error through reversing the syringe.

[illegible] A. D. Hand, American surgeon, presented a new principle in blood transfusion equipment: a pump of such construction that no syringe or check valves are used. [illegible] is continuous and may be measured.

[illegible] A. D. Lewisohn, American surgeon, in this year reported the use of sodium citrate mixed with blood to prevent coagulation. This marked a new epoch in the operation and still commonly used. The [illegible] devices are all that are needed.

Finally, anastomosis used by Dr. Alexis Carrel: [illegible] anastomosis of blood vessels (artery and vein). Direct blood transfusion (1906).

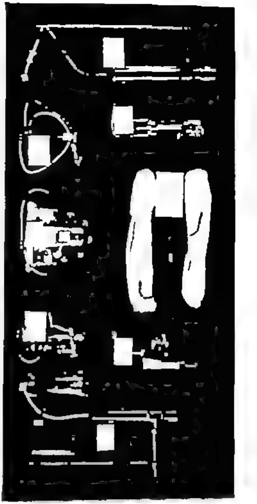


Fig. 740

the incidence of accidental transmission of disease by blood transfusion revealed thirty-five reports of syphilis, thirty of malaria, three of measles, two of smallpox, one of influenza, one of typhus fever, three of allergy, and three of tuberculosis. Undoubtedly these reported accidents represent only a fraction of similar transmissions that have actually occurred, recognized or not, in the course of thousands of blood transfusions. This forcefully implies that properly tested donors must be on call and that any donor must be tested for blood-communicable disease before being used.

SOURCES OF BLOOD

Ordinarily blood is received from living persons, either professional donors or friends, relatives, or volunteers. Occasionally it is possible to use the blood of the recipient himself, for instance in cases of ruptured internal hemorrhage. Recently a method has been developed for preserving blood from persons who have just undergone violent death, thus permitting a supply to be kept on hand for emergency work.

Preserved Blood

Professor Judine[1] states that the clinical effect of transfusions with blood from persons recently dead does not differ from that with blood from living donors. This conclusion is based on a series of 924 cases. The cadaver blood also presented advantages in that mild reactions were less frequent than with the blood of living donors.

This method was first studied experimentally on dogs and then was repeated in humans. The blood of the cadaver not only immediately increased the amount of hemoglobin in the recipient but also appreciably raised the volume of oxygen present in the blood.

Persons dying of acute heart attacks or as a result of electrocution were most suitable donors. These individuals yielded nearly 3½ liters of blood, assuring transfusions to 5 or 6 recipients. The technic of collecting the blood is comparatively simple. A glass cannula is introduced into the exposed jugular vein, and the cadaver is placed in the Trendelenburg position. The blood flows out rapidly through rubber tubing leading from the cannula into a series of 500 cc. glass flasks. The whole procedure takes five to ten minutes. The glass flasks are then capped with cotton and kept on ice for three weeks.

The cadavers are bled within six hours after death in summer and eight hours in winter. The blood is typed and the flasks labeled according to group. Serologic reactions, bacteriologic tests and autopsy findings give an excellent guarantee of safety to the recipient.

Due to fibrinolysis, the blood of victims of sudden death remains liquid during a prolonged time and thus can be preserved for more than three weeks without the addition of an anticoagulant.

PRESERVED BLOOD FROM LIVING SUBJECTS

Because preserved blood is so satisfactory for blood transfusion and because cadaver blood (aside from the repulsion which the idea of its use gives to some

[1] Prof. S. Judine, "La transfusion du sang de cadavre aux êtres humains." Presse méd. [illegible] (Dec. [illegible]), [illegible].

persons) is not available in sufficient quantities for needs of a large hospital, Cook County Hospital has devised the ingenious blood bank. To the bank are for deposit the amount of blood needed for transfusion and obtained from a donor, relative, etc., without regard to the type needed. From the bank is withdrawn an equal quantity of blood of the type needed, which is then used for transfusion.

In addition to these usual sources of blood there are many others if the hospital resources be properly used. A mother giving some blood for her child by intraplacental injection may give more against her child's need of further injection, the remainder being used for general hospital needs. A pregnant mother or a patient scheduled soon to undergo an elective operation may have some blood preserved against the day of confinement or operation, lest she may need it, and some of this blood of pregnancy may be used for premature infants since they seem especially benefited by small injections of blood from pregnant mothers. Patients in need venesection (provided not suffering from blood-borne disease) are another source of supply. Likewise those who have recovered from certain diseases, as hemolytic streptococcus infections, or have been the recipients of blood from the bank should feel an obligation to leave some blood for the specific needs of others.

The limit of blood preservation is reached—has been begun—at the present time about three weeks. The blood should then be separated and the serum preserved.

The actual procedure[2]

Depositing blood. Staff physicians will obtain from the Solutions Laboratory the chilled 500 cc. flasks which will contain 70 cc. of a 5 per cent solution of citrate solution. These flasks carry two test tubes for the collection of 5 cc. of whole blood in each for the purpose of typing and for the Wassermann test. The blood will be drawn into the flask in the usual manner and taken immediately to the Solutions Laboratory. The date, the name of the donor, his address, his color, the name of the interne, and his service should accompany the flask. By means of this system one donor only needs to be bled and he need not be typed, which greatly lessens the trouble occasioned by transfusion.

"Keeping of the blood. In the laboratory the technician at once files it away in the refrigerator, which must maintain a constant temperature between [illegible] and [illegible] degrees C., types it, tests it for sterility and the absence of syphilis, and credits it to the service that furnished the blood.

When a transfusion is required the patient's blood is typed and the amount of blood needed is requisitioned.

From the point of view of immediate availability and reliability, this method seems to have a definite place in large hospitals where many emergency cases are treated.

COMPLICATIONS

The dangers of blood transfusion may be largely prevented by avoiding the following:

Use of incompatible bloods.

Transmission of blood-borne diseases.

[2] Therapy of the Cook Hospital, Bull. 8, April [illegible], [illegible].

1. Excessively large transfusions
Contamination
2. Deteriorated or altered blood
Introduction of air emboli or blood clots
3. Too rapid introduction of blood

Agglutination and hemolysis provide the major complications and arise from errors in typing and cross matching. These reactions tend to occur especially in the blood of persons repeatedly transfused and of those people in Group O (Moss type IV). Indications of incompatibility usually occur after the introduction of 30 to 100 cc. of blood and include tingling pains shooting over the body, fullness of the head, precordial pain, lumbar pain, slow pulse, cyanosis and, sometimes, loss of consciousness. The pulse eventually becomes rapid and thready, the skin cold and the patient may have a chill followed by a high fever. Jaundice and hemoglobinuria may follow. Treatment consists of adrenalin (1:1000) in frequent doses.

Authentic reports of syphilis, malaria, measles, smallpox, influenza, typhus fever, tuberculosis and allergic manifestations having been transmitted by blood transfusion speaks for the imperative great care in the selection of donors.

Large transfusions tend to produce circulatory embarrassment, cardiac dilatation and pulmonary edema as indicated by tightness of the chest, epigastric discomfort and fullness. If these symptoms persist, immediate venesection is indicated. Likewise too rapid an introduction may produce venous distention, cardiac dilatation and symptoms similar to the above.

The prevention of contamination and air emboli is largely a matter of personal technic and alertness. Blood which has the slightest suggestion of being "granular" or clotted should be discarded or carefully strained. For safety, citrated blood should probably not be kept more than 48 hours even though well iced.

BLOOD MATCHING

A transfusion should be regarded as the transfer of living tissue from one person to another. To be successful, the blood of the donor must be compatible with that of the recipient. A simple and rapid method which makes "direct cross matching" procedure will determine this. The equipment consists of two clean test tubes for each person being tested (one for blood serum, the other for red blood cells suspended in physiological saline solution), transfer loop, glass slides and cover slips and vaseline to form "rings." The technic is as follows: From the recipient and each prospective donor the following collected in 5 cc. test tubes.

Tube 1—5 cc. of whole blood
Tube 2—1 drop of whole blood (added to 5 cc. of physiological saline solution)

Comparison from Moss to the International Nomenclature

Moss	Jansky	International Research Council
IV	I	O
III	III	B
II	II	A
I	IV	AB

or carbon monoxide. In such cases massive transfusions preceded by copious phlebotomy are indicated.

The transfer of 500 cc. of whole blood may be expected to increase the number of red blood cells by one-half million and the hemoglobin by ten per cent. Little is known as to whether such a procedure is not contra-indicated preoperatively in cases made anemic by internal hemorrhage and forgotten sources. One of the surest and most rapid ways of arresting small vessel hemorrhage is given in repeated small (100 cc.) transfusions.

METHODS OF BLOOD TRANSFUSION

The choice of a transfusion method is one of individual preference and expediency, selection being between the choice of citrated or whole blood. The former lends itself to technic simple in equipment and procedure and to circumstances in which the blood is to be transported or given at intervals or over a period of time. The administration of whole blood undoubtedly preserves certain properties altered by the presence of an anticoagulant and also produces fewer reactions, but does require more elaborate equipment. Such a summary of the statistics regarding reactions resulting from the two methods is as follows:

Method	No. of Transfusions	Range of Reactions	Average Reaction for Entire Group
Citrate Transfusion	908	10 to 18%	10.3%
Unmodified Blood Transfusion	469	10 to 4%	5.4%

The ratio of citrated blood transfusion to unmodified blood transfusion reactions for the entire series is 2 to 1, but nevertheless the citrate method is being most frequently employed.

Scannell Method

The direct transfusion of whole blood is carried out very satisfactorily using the Scannell apparatus or a modification of it. The method employs a 20 cc. syringe fitted with a three-way valve to each opening of which is attached rubber tube communicating with the donor, recipient and a container of citrate solution. The relationship is such that blood can be withdrawn and injected as desired. Likewise the citrate solution can be drawn into the syringe at times and injected into the apparatus to prevent clotting (Fig. 743).

Preparations for the application of this method are made by placing the patients on parallel tables and then bringing in close proximity the extremities whose veins are to be utilized. When the arms have been chosen a blood pressure cuff fitted about the upper portion of each extremity to act as a venous tourniquet. The skin areas in and about the cubital fossae which have been carefully scrubbed are now prepared with alcohol and iodine. The apparatus is assembled, the needles checked for smoothness and sharpness, the syringe for perfection of plunger action and ease with which it can be disengaged from its valve, following this the entire outfit is flushed and finally filled with a per cent citrate solution. The veins readily accessible for transfusion are depicted in Fig. 746.

There is the time to enter the vein of the recipient and donor. Either one of two methods are used namely direct insertion or by cutting down and exposing the vein. Let it be assumed the latter method is to be used; the technic is as follows:

Permit both to stand until the serum separates in Tube 1 (this may be facilitated by centrifuging). In the meantime construct two vaseline rings as illustrated in Fig. 744. Using a transfer loop next in the center of a cover glass one drop of recipient's serum and one drop of well mixed donor's cells, the opposite combination being created on another cover glass. Invert and seal each drop downward in the hanging drop chamber formed by the vaseline rings. Agitate occasionally to insure thorough mixing. This preparation keeps for hours and may be observed at leisure. Agglutination and thus incompatibility is manifested by the clumping of the red blood cells producing a "brick dust" appearance while the lack of agglutination is evidenced by continued homogeneity in the drop. The so-called strong cells and the portion which must be most carefully checked in that way.

Fig. 744. Direct match set of blood for compatibility. A vaseline ring being constructed with the syringe while completed ring shown with "donor" inverted and "hanging drop" created.

tube containing recipient's serum and donor's cells. The serum not used in the test is sent to the laboratory for the Wassermann test and other procedures.

INDICATIONS

The effects of supplying healthy whole blood to impoverished circulatory systems are such that the indications for blood transfusion are steadily becoming more numerous. Transfusion is of value (1) in acute anemias following hemorrhage as that of ruptured tubal pregnancy or in internal hemorrhage as from crushing injury, surgical procedures or shock resulting from blood loss; (2) in chronic anemias due to repeated small hemorrhages as from hemorrhoids or in debility which might result from malignancies or intestinal diseases; (3) as supplying blood elements to shorten clotting time, to supply functional hemoglobin, antibodies, leukocytes, volume and to increase the blood's bactericidal powers; (4) as infections of chronic nature, transfusions are especially indicated but their value decreases in acute conditions; (5) in blood dyscrasias such as leukemia, purpura, hemophilia, pernicious anemia and jaundice repeated small transfusions are of value; (6) in poisoning as might result from snake venom

Step 1. The blood pressure cuff which is already in place is inflated about the recipient's arm (of the donor and recipient, the latter receives the needle first) until a reading of 100 mm. of Hg is reached. A small amount of novocain anesthesia is injected at the selected site (Fig. 745) where an incision is made over and along the vein which is then completely exposed by blunt dissection (Fig. 745).

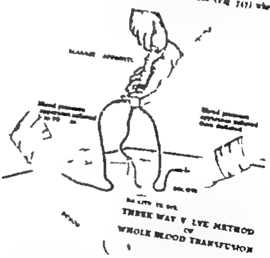


Fig. 745. Three-way valve method of whole blood transfusion.

Step 2. Two catgut sutures are passed beneath the vein and, inasmuch as the recipient is being operated upon, the distal ligature is firmly tied thus obstructing the venous return. The other ligature is moved proximalward for one-half inch and the first loop of a square knot is loosely tied. The wall of the intervening vein is then carefully picked up with a mosquito-hemostat and incised with a pair of delicate scissors until a flow of blood indicates the lumen has been entered.

Step 3. The needle or cannula is slipped into this opening in a position pointing toward the shoulder in the case of the recipient and the second and securing loop of the remaining ligature tightened about the vein and cannula (Fig. 746). The blood pressure cuff is deflated and the needle is now ready f

in case of delay it is kept open by slowly injecting citrate solution through it (Fig. 730).

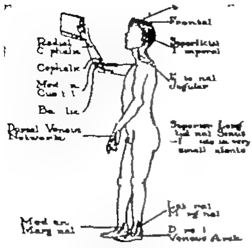


FIG. 728. Veins readily accessible for intravenous procedures.

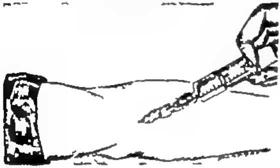


FIG. 729. Infiltration anesthesia preparatory to cutting down and exposing vein.

Another method of entering vein with transfusion needle is the direct insertion method performed with or without anesthesia.

Step. The vein is distended as described above; the needle (pointed toward the hand in the case of the donor) pierces the skin and penetrates beneath

FIG. 730. Vein exposed, caught and held preparatory to incising.

for about one-half inch (first fixing). Slowly. The point then depressed and the vein entered.

Step. The blood pressure cuff is reduced as in case of Fig. and the donor blood then available. Rolling of the vein may be prevented by de-

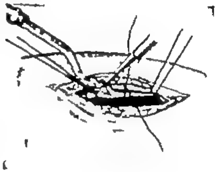


FIG. 731. Method of inserting cannula into an exposed vein for purposes of intravenous fluids directly into circulation.

fending the vessel then boldly passing cannula needle through the skin into the vein of the human donor out of the vein and externally through the skin (Fig. 732).

The apparatus is now ready for use. The valve indicator pointed toward the donor as blood is withdrawn and shifted toward the recipient as it is injected.

FIG. 733. Vein exposed and held open by gentle traction on sutures to be used.

At any time the needle may be flushed with citrate solution. After using the syringe several times or upon noting the slightest sticking, substitute another

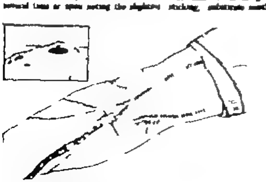


FIG. 732. Puncture of vein for the insertion of needle of large bore. Note area of infiltration anesthesia, cannula needle, tubing, vein, small scalpel, etc., for the incision of the overlying tissue which is passed superficially then depressed at the medium needle then easily entering the vein.

syringe while the original is being rinsed in citrate solution by an assistant. In this manner blood may be given rapidly, each syringeful being noted by the assistant who also observes the recipient for signs of reactions.

Lindeman Method

This is a desirable method especially when easily accessible veins are present. A 30 cc. Luer syringe is attached to a needle inserted in the donor's vein and filled with blood. It is then disconnected from the needle which is left in situ and connected to a needle which has been placed in the vein of the recipient. While the patient is receiving the blood, connect a second syringe to the donor's needle and repeat the process. Each time a syringe is used it is cleansed in citrate solution. It is well to have several syringes available.

Scannell Method

Samuel George Scannell devised an apparatus which approximates continuous flow transfusion (the thought being to keep the blood of both donor and recipient in constant motion, thus avoiding clotting with its possible danger of thrombosis or an embolus).

The time-saving element, so essential in an emergency case, is an important feature in connection with the use of this apparatus. Two syringes are used at the same time, operating simultaneously, one drawing blood from the donor at the same time that the other is delivering blood to the recipient.

The device consists of two syringes (Fig. 734), a housing block and a weighted valve which are supported on a base which may be clamped to a table. Rubber tubing is connected to the distal ends of the donor and recipient tunnels which are bored in the housing block; the free ends of the tubing are attached to the proper style needles for insertion into the donor's and recipient's veins. All tunnels of the apparatus, rubber tubing, needles and syringes are filled with saline solution (to expel all air) by means of a syringe, the three-way stop cock is closed, the needles inserted into their respective veins, and the apparatus is ready to function. The valve-arm is turned to a stop on one side of the housing block. The plunger of the syringe, whose tunnel is connected with that of the donor tunnel, is slowly raised until the syringe barrel is filled with the donor's blood. The weighted valve is now turned through an arc of ninety degrees to the opposite stop. This action shifts the stream of blood in the syringe just filled from the donor tunnel to that of the recipient-tunnel, and at the same time connects the donor tunnel with that of the syringe still empty. The plunger of the filled syringe is now depressed, forcing the donor's blood through the re-

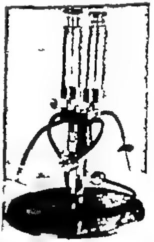


FIG. 734. Scannell blood transfusion apparatus.

opposite-turned. At the same time the plunger of the still empty syringe is raised filling the barrel of that syringe with the donor's blood. The valve arm is then turned back ninety degrees to the first position. This again reverses the direction of the two streams of blood, bringing the syringe tunnels into communication with the donor and recipient tunnels as they were before. The filled syringe is emptied into the recipient tunnel and the emptied syringe barrel is again filled with blood from the donor tunnel at the same time. The valve is again turned through an arc of ninety degrees to the opposite side. The procedure is thus continued until

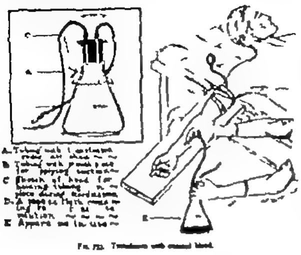


FIG. 733. Transfusion with citrated blood.

the desired amount of blood is transfused. The plungers of both syringes are always moving in opposite directions simultaneously,—while one is filling the other emptying.

Citrate Method

The equipment for this method consists of a 1,000 cc. Erlenmeyer flask containing 75 cc. of a 2.5 per cent citrate solution. The neck is fitted with a two-hole stopper: one hole permits the entrance of a rubber tube with a needle of large bore attached. The other hole allows the exit of a suction tube. Each unit is easily handled and autoclaved. In use in sample the needle is inserted and the blood allowed to flow into the flask until the 575 cc. mark is reached (500 cc. may be safely withdrawn). (Fig. 733.) If the flow becomes slowed the donor opens and closes his hand while the gentle negative oral pressure is exerted upon the mouthpiece of the suction tube. The blood is ready for immediate

use or it may be preserved for several days when well iced. Administration is by means of an intravenous continuous drip apparatus using a needle of large bore. The recipient's vein is entered and the apparatus checked for function using a flask of physiological saline solution. When it is seen that the vein is receiving the solution well the flask of blood is substituted for the saline solution.

Auto-Transfusion

Not infrequently during operative procedures to produce hemostasis a very large quantity of blood is found free in the body cavities. This is especially true in ruptured ectopic pregnancy, torn liver, spleen or kidney and in wounds of the heart producing a hemopericardium. Thies as early as 1914, reintroduced this blood into the patient's circulatory system with marked improvement.

A technic that has been gradually evolved is sponging out the cavity with "lap pads" which have been thoroughly wrung out in a per cent citrate solution and which are in turn wrung out into a sterile container. For each 100 cc. of blood recovered 10 cc. of per cent citrate solution is added. When all available blood and clots have been collected the mixture is repeatedly filtered through layers of gauze previously wrung out in citrate solution. The blood is then ready for immediate administration as described in the citrate method for blood transfusion.

Tzanck's Blood Transfusion Aphorisms*

It is less important to discover daily new indications for blood transfusion than to use adequately those that already exist.

The fixity of blood-groups is as immutable as that of the species. Faulty (inaccurate) examinations are the basis of the so-called change of blood groups.

3. The blood-group engraved on the "identity plate" of an individual protects lazy blood-determinations and invites accidents.

4. Painstaking control of blood-compatibility among individuals will be the determining factor in eliminating serious accidents of blood transfusion. In fact, by means of a thorough study of the compatibility of blood of the donor and of the recipient, one can predict the probabilities and frustrate the occurrence of serious accidents.

5. Direct tests of blood-compatibility are invaluable.

6. All transfusion apparatus are good, provided they are well constructed, are easily handled and securely arranged.

7. The operation of blood transfusion should never be performed on an automatic basis, such as substituting automatic apparatus which at best is a blind procedure: every movement of the operation should be constantly under the control of the operator.

8. A slow deliberate beginning in a blood transfusion is a good investment on the point of security.

9. Since the untoward reactions observed in blood transfusion are not due to "bad blood" it is folly to offer the customary explanations that such is the case or because of "changing of blood groups" (such do not exist) or because of the deleterious actions of [illegible] which thus far has not been proven or because

* Arnold Tzanck—Problèmes Thérapeutiques. Transfusion de la Transfusion Sanguine. Masson Co., Paris, 1933.

of the toxicity of the anticoagulant which is assumed or because of the use of such and such apparatus. Such reactions are due to the intolerance of the individual.

10. Most of transfusion incidents are not uncovered by tests: occasionally they are suspected after a painstaking clinical inquiry; they are usually benign.

A chill during transfusion depends less on the blood injected than upon the condition of the patient. It occurs most frequently in subjects suffering from febrile affections.

From a practical point of view syphilis, as a rule, is not transmitted from a donor whose Wassermann test is negative and who suffers from no clinical lesion.

13. Blood reaction is not always positive in individuals affected with chronic paludism. However if it is negative, paludism is not transmitted.

14. Transfusion should reduce the mortality in hemorrhages in respect to reduce the mortality in infections.

15. In massive hemorrhage resort to massive transfusion; in repeated hemorrhages do repeated transfusions.

16. The pulse of a patient is an index as to the quantity of an existing hemorrhage; symptoms of collapse are most important, the latter, however, may be due to other causes.

17. In cases of collapse from hemorrhage the quantity of fluid injected plays more important rôle than its quality.

18. If a transfusion or injection of serum is without effect in states of collapse, the latter is not due to hemorrhage.

19. To inject serum before securing hemostasis is an error as it hinders the natural defenses of the organism.

20. In the presence of a serious visceral hemorrhage everything possible should be resorted to before attempting surgical intervention. One should aim at "spontaneous hemostasis, then fight death from hemorrhage by replacing the blood lost; finally if death seems inevitable consider operation supplemented by sufficient blood transfusion.

If one is assured of an ample blood transfusion, shock is not a contra-indication to operative intervention.

22. In "big shock" small transfusions.

23. Intracardiac transfusion is only permissible in desperate cases and only after failure to enter a vein, particularly failing to transfuse through the femoral vein.

24. When a patient has lost a great quantity (many liters) of blood danger lies not in abundant transfusion but in too little transfusion.

25. In pernicious anemia Whipple's method is the basic treatment. Blood transfusion may be useful in the initial period, to allow hepatotherapy time to act in the course of treatment and to improve a stationary blood-count. Transfusion treatment is of value only in the treatment of a hemoglobin-able infections.

26. Independently of specific immunity an untreated blood may furnish non specific elements to hasten recovery (phylactic-transfusion).

27. True cases of "blood transfusion deaths" are those where blood transfusion was not practiced.

OPERATIONS ON THE LYMPHATICS

HANDLEY'S OPERATION ON THE LYMPHATICS

The procedure establishes artificial passageways in vessels which are obstructed.

A number of long-eyed probes and several lengths of No. 12 tubular woven silk are required in addition to the other instruments for operation.

Operation—Upper Extremity

Step 1. Make an incision in the skin just above the wrist in the midline of the forearm about an inch in length.

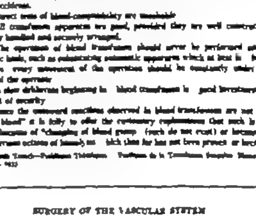


FIG. 734. Handley operation—lymphangioplasty of the upper extremity. A, anterior view, posterior view.

Step 2. Insert a probe in the subcutaneous areolar tissue near the elbow directing it upward and outward.

Step 3. Grasp with a hemostat a double loop of No. silk, twice the length of the arm. Wrap half of it in a sterile towel and thread a probe with the other half. The probe and silk are now pulled out of the incision leaving a double line of silk in the subcutaneous channel (Fig. 734 A).

Step 4. Insert the probe again and bring the silk out through the incision made near the insertion of the deltoid muscle.

Step 5. Introduce another probe into the wound directing it upward and inward bringing it out through another incision as shown in the illustration. Next

thread probe with the silk which was wrapped in the sterile towel. Retract the probe and silk through the incision mentioned above. Remove the hemostat so that the silk remains imbedded.

Step 6. Introduce the silk under the skin from to d. Insert probe through d directing them subcutaneously over the shoulder and bringing them out through an incision at the posterior margin of the deltoid (Fig. 734 B). Insert double line of silk under the skin of the arm posteriorly as shown

Fig. 735. Handley operation for lymph stasis of the lower extremity. [illegible]

in the illustration making total of 8 threads which are brought out through the incision at the posterior border of the deltoid.

Step 7. Arm the probe with two of these threads cut off so that they are about 4 inches shorter than the probe. Introduce the probe, eye first, through the incision in the back of the shoulder piercing the skin of the back. Since the silk is shorter the probe outwards until. Pull out the probe cautiously leaving the silk in its path. This is done until all of the threads emerging from the shoulder incision are imbedded in different directions into the subcutaneous tissues of the back.

Step 8. All incisions are closed with sutures.

Comment. According to Handley, this operation is contra-indicated:
1. After removal of the breast for carcinoma.
2. Where general anesthesia is prohibited.
3. When it is necessary to insert threads through cancerous tissue.
4. When there is growth in the shoulder or axilla or any nerve-plexus pain.
5. In case of secondary growth or pleural effusion where benefit is only temporary.

Fig. 736. Lymphangioplasty, Handley's method. (Used successfully by A. S. [illegible] Medical Journal, XX, [illegible]) [illegible]

Handley believes this operation should be reserved for severe cases of lymphostasis.

Operation on Lower Extremity

This procedure is very much the same as that followed in the upper extremity except that it is more difficult to perform on account of the skin being

more thickened and irregular causing infection to be more likely to occur (Fig. 735).

Operation on the Face

This operation was performed for the relief of usual edema of an eyelid which had failed to respond to other treatment.

Step 1. Make small curved incisions near the central part of both the upper and lower eyelids. Make similar incisions lateral to the outer canthus. (Fig. 736.)

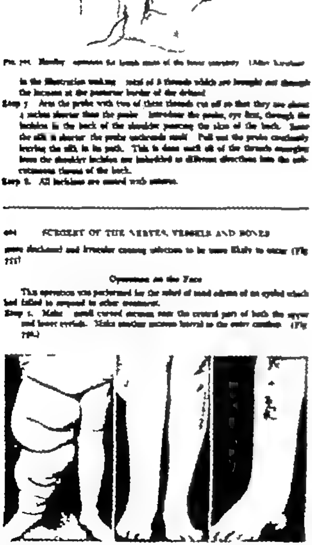


Fig. 737 Fig. 738 Fig. 739

Fig. 737. Elephantiasis of the right lower extremity. [illegible]

Fig. 738. Elephantiasis involving the right foot and leg. [illegible] Kondoleon operation. [illegible]

Fig. 739. Elephantiasis. Same as preceding, lateral view of affected limb.

Step 2. Introduce several strands of silk under the skin of both lids and carry them beyond the outer canthus. They are then directed downward through an incision lateral to the angle of the mouth and the ends imbedded under the skin of the cheek near the ramus of the lower jaw. Satisfactory recovery followed.

KONDOLEON'S OPERATION FOR ELEPHANTIASIS OF THE LOWER EXTREMITY

This operation consists in removing an oval-shaped portion of skin and fascia from the thigh and leg thus directing the course of the lymph from the superficial lymphatics to the deeper parts of the muscles (Figs. 737, 738, 739).

Operation

Step 1. Make an elliptical incision beginning at the crest of the ilium and extending to the external malleolus. Deepen the incision to include the subcutaneous adipose and areolar tissues and remove the segment outlined.

Step 2. Clamp and ligate all blood vessels as they are encountered. This is important as there is likely to be considerable hemorrhage.

Step 3. Dissect back the skin margins for approximately an inch on each side and remove an oval-shaped segment of fascia corresponding to the portion of skin removed.

Step 4. Close the incision by means of No. running chromic catgut suture. Apply an alcohol dressing.

Step 5. Bandage the leg tightly from the foot to the groin and place at a degree angle which is maintained for about three months. The patient may be accorded bathroom privileges after the leg is completely healed but aside from that should remain in bed with the leg elevated.

Comment. The above procedure may be modified as follows:

1. The operation may be performed on both sides of the limb at one time or a period of 10 days may be permitted to elapse between the two stances.

2. If for some reason complete removal of the fascia is not deemed advisable, it may be "windowed" in different places.

3. In some instances linear incision is made in the skin and only the fascia is removed.

4. The elevating of limb which follows this operation is most harassing to both surgeon and patient. To prevent early recurrence the patient should be made to understand that a long period of rest while the limb is maintained in an elevated position is most essential. Although recurrence is almost sure to follow at some time, the operation should not be considered futile since reparation of the operation is comparatively free from danger and the patient is made much more comfortable by the procedure.

CHAPTER 22

ORTHOPEDIC SURGERY

GENERAL OPERATIVE CONSIDERATIONS

OSTEORRHAPHY

(See also open operation for fractures. Figs. [illegible], p. [illegible])

Suturing of bone is done for solutions of continuity of a given bone and may be done by (a) absorbable suture materials, (b) nonabsorbable sutures.

Absorbable suture materials provide the surgeon with his most nearly physiologic means of direct bone repair. Of these, kangaroo tendon is most frequently used. The former has long been used for repairs in and about joints and

A B C

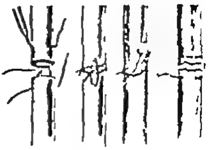
FIG. [illegible]. A, B and C illustrate methods of [illegible] fractures.

for the fixation of small bone fragments or grafts. The use of live bone either as an intramedullary peg or as a graft is an effective means of reinforcing a bone shaft, preventing bone deformation, and in treating non-union, but it incurs certain technical difficulties that necessitate instruments and experience to overcome. Close bone defects may be considered and suited to repair by covering them with live periosteum. [illegible] use [illegible] plates for fixation purposes and although absorbable they provoke undesirable adjacent tissue reactions.

Nonabsorbable sutures are almost legion in number. One of the earliest methods was that of wiring bone fragments (Fig. [illegible]). Wires constructed of silver, annealed steel, bronze and aluminum are wrapped about or passed through drill holes in fractured bones in an effort to provide stability and maintain position (Fig. [illegible]). Nails of bone, ivory, bronze and other metals are also used (Fig. [illegible]). Steel plates (Lane's, Sherman's) have the advantages of being readily available and easily applied although a secondary operation may be necessary to remove them. This is likewise true of Parham's bands. Lane's plates (Fig. [illegible])

[illegible]

are constructed of vanadium steel and are made in varying lengths so as to accommodate two to eight screw holes.



A B C D

FIG. [illegible]. A, B, C and D depict how transverse or oblique fractures are brought together with steel wire or [illegible] loops.

A B

FIG. [illegible]. A, Wire applied incorrectly. B, correct manner of applying wire [illegible] placed at right angles to the line of fracture.

Some of the objections to their use as a routine measure are:

Interference with the nutrition of the bone due to the necessity of using long plates.

Occasionally delayed or nonunion may occur as a result of the too absolute fixity of the fracture fragments.

3. Local rarefaction of the bone by the screws frequently lessening its hold on the bone.

Infection of the wound is usually associated with death of the bone underneath the plate.

5. The plates should never be used in open fractures when the possibility of contamination exists.

Most [illegible] points out that:

Metal plates, such as other foreign materials, may remain in situ indefinitely under favorable conditions.

One should never hesitate to remove them whenever it becomes necessary.

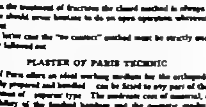


FIG. [illegible]. Lane plating for fracture of long bone. Clamp maintains the fractured fragments in position. The Lane plate is kept in place by screws passing through previously drilled holes in the bone.

3. That in the treatment of fractures the closed method is always preferable but one should never hesitate to do an open operation wherever indicated and that:

In the latter case the "no contact" method must be strictly and scrupulously followed out.

PLASTER OF PARIS TECHNIC

Plaster of Paris offers an ideal working medium for the orthopedic surgeon. When skillfully prepared and handled it can be fitted to any part of the body and provides retention of a superior type. The moderate cost of material, ease of application, stability of the finished bandage and the cosmetic results, give this fixation method unique properties.

Plaster bandages may be purchased or "hospital-made." In the latter case gauze crinoline is torn into three yard strips, three, four and seven inches wide. From the rough edges of each strip three or four threads are pulled. The meshes are then filled with dry plaster as the crinoline bandage is formed into an even but not tight roll. This is best done by moving a small amount of plaster of paris back and forth over the crinoline with a tongue blade. Each roll is then wrapped and tied in a paper napkin to be placed in a moisture proof container for storage.

Plaster of Paris (calcium sulphate) is crushed gypsum which has been subjected [illegible]

jected to intense heat so that water of crystallization is driven off. When mixed with water re-crystallization or "setting" occurs. Dental plaster is an excellent grade of material, the setting speed of which may be hastened by the addition of salt or delayed by glycerin or glue. In general, slow setting is desirable. The process may be hastened, however, by the application of a heat cradle or an electric fan, care being taken not to burn or chill the patient.

A limb which is to be encased in plaster should be carefully cleansed and then dusted with talcum. This is followed by bringing the extremity into the desired position and applying a preliminary padding. Such a protective covering, be it sheet wadding or felt, is applied sparingly or only over joints or bony prominences. Later shrinkage with resultant looseness is thus avoided. If the cast is to be bivalved ample padding facilitates the task and protects the patient from being injured during the procedure. There is at present, in selected cases, a decided and justified tendency to apply plaster bandages directly to the skin surface.

Plaster rolls are made ready for use by immersing them on end in a porcelain lined bucket filled with tepid water. Each roll remains submerged until air bub-

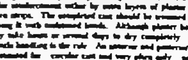


FIG. [illegible]. Plaster knife, a piece of sheet steel, sharpened as illustrated and a handle of one plaster bandage formed and fitted to the operator's hand. One end of the blade is used for cutting and the other for prying.

bles cease to rise, at which time it is grasped at each end and squeezed, toward its center, gently twisting at the same time. The bandage is then applied evenly but not tightly encompassing that it neither expands nor contracts in setting. After each turn the plaster is rubbed and molded. The direction of the plaster strip may be changed at will by folding a triangular dart in the bandage. Points of strain call for reinforcement either by extra layers of plaster bandage or by metal or wooden strips. The completed cast should be trimmed and then "polished" by rubbing it with moistened hands. Although plaster hardens in a few moments it may take hours or several days to dry completely. Until this has taken place, gentle handling is the rule. An anterior and posterior mold may frequently be substituted for a circular cast and very often only a posterior mold is necessary. It is readily prepared, easily applied and of light weight. Compression symptoms are reduced and the fracture site is made easily accessible (Fig. [illegible]).

Once a plaster cast has been applied the operator must then (a) determine bony relationships by x-rays, (b) watch for constrictions caused by too tight an application, (c) detect early evidence of pressure sores, (d) prevent deformities and destruction of the cast, (e) repair limited-early plaster breaks or cracks, (f) guard against infestation of the cast. Do not give morphine for pain. Investigate.

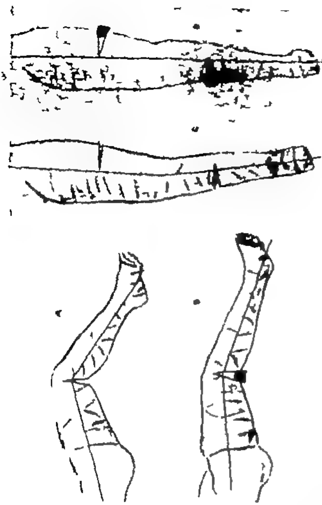


Fig. [illegible]. Method of [illegible]

The purpose of a plaster cast is to maintain proper postural alignment. If radiological evidence shows otherwise, immediately remove the cast and reapply it until perfection is obtained (Fig. [illegible]).

Fingers and toes should be left exposed and frequently observed to see that they are warm, pink, sensitive and capable of voluntary motion. Body casts require a window over the epigastric region to permit abdominal expansion and for respiratory [illegible].

The [illegible] of a plaster cast may give rise to pressure areas in which case trimming or a [illegible] change is needed. When bony prominences are being traumatized, [illegible] and spreading of the cast is preferable to cutting a window.

Moisture from the patient's excretions frequently soils or destroys a cast. This may be largely prevented by proper exposure along the buttocks, careful placement of bed pans and by protecting the cast. The latter may be done by edging the region about the buttocks with rubber sheeting, oiled silk or painting it with several coats of white enamel. The last procedure is useful upon plaster casts applied to children as it permits washing with soap and water. Evidence of purulent drainage from within a cast can be detected if the surgeon will regularly examine the cast or smell it.

Cracks or breaks in plaster casts should be immediately repaired. Clean out and widen the crack, fill with plaster cream and cover with several layers of plaster bandage. An aluminum or wooden strip applied splint like also provides security.

Crumbs of food carelessly dropped into a cast may attract ants and bedbugs which find body casts to their liking! Once infested, the remedy is the application of a new cast.

The removal of a plaster cast may become a laborious job when not properly performed. If the cast is to be destroyed upon removal place the part in hot water for 10 minutes and the plaster can be easily cut away. When bivalving is necessary proceed before the cast is entirely set, always [illegible] the posterior portion. In event the cast has completely hardened a pair of [illegible] plaster scissors is very useful. More inexpensive is a small cross-cut carpenters' saw. [illegible] placed along the proposed line of cutting readily softens plaster. Vinegar acts equally well.

In fashioning orthopedic appliances a plaster model is necessary. This is made by covering the affected part with stockinet and applying plaster bandage until a firm cast is built up, immediately and carefully bivalving it. When setting has occurred, the cast is removed and accurately approximated. Remove the stockinet lining and coat the inside of the cast with soap. Plaster cream is poured into the hollow mold and allowed to set after which it is removed and "fired" for complete drying. The brace maker uses this positive model in the construction of corrective and supportive appliances.

OPERATIONS ON BONES

OSTEOCLASIS

This refers to producing a simple fracture of a bone by external force in an effort to overcome a deformity. The surgeon directs his efforts so as to produce

complete break at the site of maximum deformity. Following this the position of the fragments is corrected and a plaster of Paris cast is applied. The surgeon may choose to perform the operation manually or with an osteoclast.

Manual Method

Step 1. Place the patient on a low table. Prepare the limb surgically and cover with sterile drapes. Place a wedge under the deformity at right angle to the long axis of the bone.

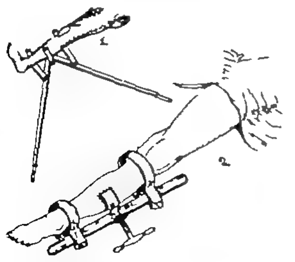


Fig. [illegible]. Osteoclasis. [illegible] osteoclast [illegible] Rizzoli osteoclast applied to limb.

Step 2. Grasp the limb on either side of the fulcrum and press downward until the bone is completely fractured.

Step 3. Correct the deformity and encase the limb in plaster of Paris.

Osteoclast Method

Step [illegible]. Prepare the limb surgically and cover with sterile drapes.

Step [illegible]. Fit the osteoclast to the extremity seeing that the fulcrum and upper fulcrum is at the proposed fracture site. Close the instrument until the bone is fractured, a procedure which should take not more than eight seconds (Fig. [illegible]) or use the Rizzoli osteoclast.

Step 3. Correct the deformity and encase the limb in plaster of Paris.

OSTEOTOMY

This means a simple, direct division of bone. Its use is confined to the correction of bony deformities occurring near joints in which case splinting, manipulation and osteoclasis are to no avail. It is indicated in deformities due to rickets, ankylosis in faulty position, coxa vara and genu valgum. The procedure may be linear or cuneiform in type; however in either method the bone should be manually fractured after three-quarters of it has been cut through with the osteotome. The postural correction thus effected is maintained with a plaster of Paris cast.

Linear Osteotomy—Subcutaneous Method (Genu Valgum)

Supracondyloid osteotomy for genu valgum (Macewen) will be described as a typical example.

Anesthetize the patient. Apply a tourniquet. Flex the knee to an angle of 35 degrees.

Step [illegible]. An imaginary horizontal line is drawn one finger's breadth above the superior tip of the internal condyle. Another imaginary vertical line is drawn

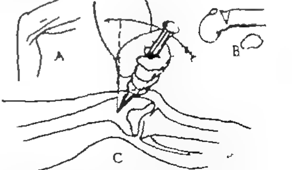


Fig. [illegible]. Macewen's method of osteotomy for genu valgum [illegible]. A. [illegible] for supracondyloid osteotomy. B. Lines of incision. C. The chisel is held [illegible] [illegible] The [illegible] [illegible] up and down [illegible] the bone of the [illegible].

longitudinally one half inch in front of the adductor magnus tendon. At the point where these lines cross introduce a long-bladed knife directly to the bone, make an incision upward of sufficient size to admit the largest osteotome (Fig. [illegible]).

Step 2. Leave the knife in situ which acts as a guide to Macewen's largest osteotome down to the bone. The blade of the osteotome is turned transversely to the bone. Guide its edge to the postero-internal border of the

bone; with blows of [a] mallet it is made to divide the inner and posterior part of the bone first; then the instrument is driven forward and outward until the outer aspect of the triangular surface of the back of the femur is reached. The remainder of the compact part of the bone is recognized.

Step 3. After three-quarters of the bone has been cut through, the remainder of the bone is fractured by grasping the thigh with one hand and the leg with the other and applying of leverage force.

FIG. 798. A, Bowlegs. Linear osteotomy. Appearance of patient before operation. B, X-ray of both legs of patient above [illegible] preceding illustration.

Step 4. Remove the osteotome. Rectify the deformity by manual overcorrection.

Step 5. Remove the tourniquet and provide hemostasis. Apply an aseptic pad over the wound. Place the limb in [a] plaster of Paris compartment.

Linear osteotomy may be done by the open method. An incision exposes the site of the bone to be sectioned. The soft tissues having been divided and thoroughly retracted, an osteotome or saw divides the bone. A Gigli saw is of advantage in this connection. The open operation is safer though the incision is of necessity larger.

OPERATION FOR BOWLEG (GENU VARUM) AND FOR "KNOCK KNEE" (GENU VALGUM)

The external bowing of the femur and bones of the leg may be corrected either by linear or other osteotomy or by osteoclasis (Fig. 798).

Linear Osteotomy

Step 1. Note which bone and what part of it is most bent. It is there that section must be made. If the middle third of the femur is the part most affected, make [a] vertical incision through the soft parts down to the bone on the antero-external side and proceed as in supracondylar osteotomy for knock-knee, only in this case putting the bone from without inward.

If the tibia is most affected, incise the soft parts vertically down to the bone over its inner surface at the point of greatest curvature. Introduce the

FIG. 799. C, X-ray of deformity of tibia and fibula by linear osteotomy [illegible] same patient. D, Same patient four months after operation.

osteotome and turn [it] transversely to the bone and divide the cortical bone of the inner and outer sides of the tibia especially that of the anterior margin. Fracture the posterior layer of cortical bone by manual force and forcibly fracture or bend the fibula. It may be necessary to introduce [a] narrow osteotome and divide the latter bone.

If the femur and tibia are both markedly curved osteotomy on both at the same sitting. The operation should be repeated at all points where necessary.

Step 2. Place the limb in good position in [a] plaster of Paris cast and treat as an ordinary fracture.

Cuneiform Osteotomy

In this operation [a] wedge-shaped section of bone is removed, the size depending upon the needs of the case. The operation is usually performed for anterior

angular curvature of [a] long bone, as in the deformities produced by rickets or for the correction of hallux valgus. The surgical correction of genu varum is carried out as follows:

Apply [a] tourniquet.

Step [1]. Incise over the most prominent part of the tibia, down to the bone. Reflect the periosteum. Retract thoroughly.

Step 2. After cleaning the bone subperiosteally outline the base of [a] wedge with [a] chisel, cutting through the cortical bone with [a] rugine. Hold the chisel

FIG. 800. A, Genu valgum ("Knock Knees") before operation. B, Same patient after operation.

like an osteotome. The base of the wedge should correspond to the apex of the angular deformity and should be smaller than that which is thought will be necessary. It can later be enlarged as required. Chisel off slices of bone until the proper sized wedge has been removed. Do not cut through the entire thickness of the bone. The posterior undivided portion corresponds to the apex of the wedge and can be fractured manually. The limb [is] now straightened. If the fibula interferes with the straightening of the limb, divide it with [a] chisel (Fig. 800).

Step 3. Remove the soft tissues if necessary. Dress. Immobilize in plaster of Paris.

COXA VARA

Normally the neck of the femur forms with its shaft an angle of [1]30 degrees. When this angle is reduced to 115 degrees or less [a] condition termed coxa vara is said to exist (Fig. 801). This state arises from certain traumatic or infectious

assaults upon the neck or epiphysis of the femur, deficiency diseases and rickets. It is seen most frequently in young males. The condition is recognized by the resulting limp, prominence of the trochanter when the thigh is flexed, tilting of the pelvis and limitation of abduction.

Step [1]. Incise along the external thigh over the course of the femur from its greater trochanter downward for 3 inches. Spread and cut the heavy muscles

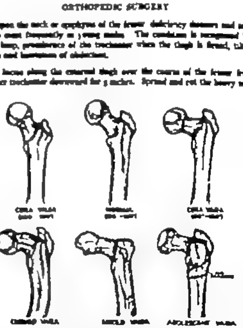


FIG. 801. [illegible] rickets, tuberculosis and senile osteoporosis. [illegible] The adolescent type may be due to separation of the femoral epiphysis or disease.

down to the bone. Reflect the periosteum and widely expose the subtrochanteric region.

Step 2. Outline and remove [a] wedge of bone designed to allow the femur to be abducted into its correct position. The shaft is not completely cut through about one-fourth of its cross area being broken through manually.

Step 3. Close the wound loosely. Dress. Immobilize in extreme abduction.

OPERATION FOR CLUB-FOOT

The condition known as club-foot or talipes may be either congenital or acquired and has [a] great many varieties. Congenital talipes equinovarus is the most commonly occurring form of club-foot. Correction is either by manipulative operation. The latter procedure may consist of severing of tendons alone may be combined with osteotomy upon the bony structures.

Lorenz recommends the following operations for club-foot.

A *Osteotomy*

Linear division, navicular bone from the sole (Hahn)
Linear division, tibia and fibula above the ankle.

B *Enucleation*

Of one bone
Of the cuboid (Solly)
Of the astragalus (Lund, Mason)
Of the astragalus with resection of the point of the external malleolus (Mason, Reid)
d Curettement of the spongy part of the astragalus, leaving the articular surfaces intact (Verebely)
Of the astragalus plus removal of wedge with base external from the anterior process of the calcaneum (Hahn)
Of several bones
f Enucleation of astragalus and cuboid (Hahn, Albert) and of the navicular bone (West)
g Enucleation of the navicular and cuboid (Bennett)

C. *Resection*

Of the head of the astragalus (Lucke, Albert)
Of portion of bone from the external half of the neck of the astragalus (Hueter)
3 Resection of wedge from the outer and upper sides of the tarsus (O Weber Davis, Colley R Davy Schede, Meusel, Konig, etc.)
Resection of two wedges perpendicular to each other with their bases directed outwards from the astragalo-calcaneal and Chopart's joints (Rydygier)

D Extirpation of ossifying centres of the astragalus in young children (Ogston's operation)

Tenotomy for Talipes Equinovarus (after Ober)

Step Make fish-hook incision, with forward bend around the inner malleolus, beginning midway between the posterior border of the tibia and the tendo Achillis, passing under the inner malleolus and forward over the displaced scaphoid. The incision is carried down to the deep fascia and flap dissected upward exposing the deep fascia, and annular and deltoid ligaments.

Step 2. Through the annular and deltoid ligaments make semicircular incision down to the bone and surrounding the internal malleolus. Dissect this ligamentous flap from the bone in downward direction including both layers of the deltoid.

Step 3 Continue the curved incision downward, dividing the superior calcaneo-scaphoid ligaments and carrying the incision down to the bone. These ligaments are then separated from the inferior surface of the os calcis with an osteotome or blunt dissector down to the inner surface of the os calcis. The

tendo Achillis may have to be cut and also, perhaps, the plantar fascia according to conditions.

Step 4 The foot is seized by its fore part and heel and brought into an overcorrected position. The overcorrection should be moderate for few days and then increased. The foot is then put up in plaster of Paris cast

Osteotomy for Talipes Equinovarus (after Mercer)

Step 1. Carry an incision forward from below the lateral malleolus along the dorsum of the foot until the area over the calcaneum bone and the mid-tarsal joint is exposed.

Step Locate the mid-tarsal joint. Behind it lies the calcaneum from which wedge of bone is removed whose base is directed outward. In front is the cuboid upon which similar osteotomy is performed. From the head and neck of the talus curved wedge with its base upward and outward is removed.

Step 3. Make an incision along the medial side of the foot and sever the talo-navicular capsule and deltoid ligaments. Following this the foot can be manipulated into its correct position.

Step 4. Encase in plaster for period of two weeks. Remove the cast and again apply bringing the foot into an overcorrected position where it remains for five weeks.

Forcible Rectification

Hands or wrench may be used. Tenotomy of the tendo Achillis (which see) usually precedes this as sometimes does tenotomy of the plantar fascia.

MANUAL RECTIFICATION

Step 1. Grasp the heel and ankle in one hand and the distal end of the foot in the other. Leave the calcaneocuboid articulation unsupported by the hand. Lay the convex surface of the calcaneocuboid articulation against the edge of wedge of wood covered by towel which acts as fulcrum (Figs. 771-772)

Step 2. Forcibly straighten or unfold the foot by compressing its convex side against the fulcrum and stretching or tearing the structures on the concave side. Overcorrection may be accomplished at one sitting in young children. Do not tear the skin; if it seems about to tear postpone further manipulation until later. Sometimes as many as four sittings about week apart are necessary to accomplish the desired results.

Step 3. While the patient is still anesthetized, encase the foot in plaster of Paris. Maintaining the foot in an elevated position for 24 hours will prevent swelling.

Comment Overcorrection is the aim and should be kept rigidly enforced. Bollan combines forcible rectification with tenotomies, dividing the fascia and ligaments as necessary. He recommends the application of cotton batting to prevent the formation of ridges on the inside of the plaster which is applied heavily enough so that the patient may walk on it for four or five months. The dressings should not be removed but if they slide off, pad the ... of ... cut to shape of the sole, fix it to the foot with adhesive

straps and apply plaster. Wrap the whole foot and leg in cotton before applying the foot-piece. Plaster must be applied to the knee; when it is

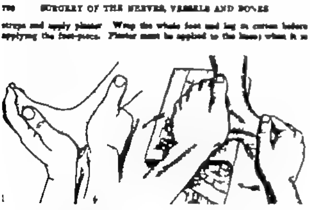


Fig. 771 Fig. 772
Fig. 771 Method of manual correction of club-foot (after Berger and Banzet)
Fig. 772 Manual correction of club-foot over wooden block (Hahn)

removed the foot should remain in an overcorrected position. The operation may be performed at any age.

INSTRUMENTAL RECTIFICATION

The Thomas wrench very useful in forcible rectification; the foot may be twisted and bent in any direction with speed as requisite (Fig. 773)

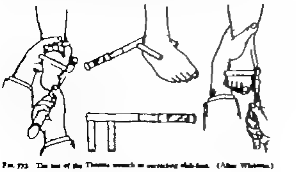


Fig. 773 The use of the Thomas wrench in correcting club-foot. (After Whitman.)

Enough force should be applied to destroy for time the resiliency of the soft ... so that the foot is relaxed. Following this retention brace is applied. A few days later when the soft parts recover their resiliency repeat the procedure

until there is no recurrence. Keep the foot immobilized until the slack is taken up and the parts are oriented. In some instances the tendo Achillis pulls upward on the inner side of the tuberosity of the calcaneum retarding correction of the varus for which R. Jones recommends the following treatment:

Step Make T-shaped incision exposing the tendo Achillis. Split the tendon longitudinally. Separate the inner half from its insertion.

Step 2. Insert the inner segment of the tendon under the outer segment. Suture its free end to the periosteum of the os calcis outside and in immediate juxtaposition to the attached half. Freshen the opposing surfaces of tendon and suture them.

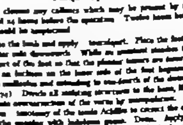


Fig. 774 Phelps' operation for club-foot

Phelps' Operation

Soften and cleanse any callouses which may be present by means of soap poultices applied 24 hours before the operation. Twelve hours before the operation the foot should be sterilized.

Step Elevate the limb and apply tourniquet. Place the foot on sandbag with its outer side downwards. While an assistant steadies the heel, grasp the distal part of the foot so that the plantar tissues are tense.

Step 2. Make an incision on the inner side of the foot beginning directly in front of the malleolus and extending to one-fourth of the distance across the sole (Fig. 774). Divide all resisting structures to the bone, if necessary.

Step 3 Complete overcorrection of the varus by manipulation.

Step 4. Perform tenotomy of the tendo Achillis to correct the equinus.

Step 5 Pack the opening with iodoform gauze. Dress. Apply plaster of Paris bandage extending up the calf maintaining the limb in position of overcorrection.

Step Elevate the limb for twenty-four hours after removing the tourniquet. The dressings need not be changed for two or three weeks if they are clean. The incision is usually healed in that length of time.

TARSECTOMY

In some instances the above operation is inadequate for producing overcorrection. After division of the soft parts has been done, incise the neck of the astragalus with chisel. Do not insert the gauze in the bone cleft when packing. After treatment. The extremity should be encased in plaster of Paris for

six to eight weeks (renewed when necessary). Massage and exercises are instituted after this and a good, strong shoe later used. No special club-foot shoe need be worn following this operation.

Jones Operation

Step 1. Make an incision beginning below the insertion of the plantar fascia on the inner side of the foot, directly below and anterior to the internal malleolus, extending forward and upward to a point on the first metatarsal bone and nearly to the metatarso-phalangeal articulation (Fig. 775).

Step 2. Make a second incision beginning over the astragalo-scaphoid articulation, extending forward and downward, connecting the first incision near

Fig. 775. Jones operation for club-foot.

the metatarso-phalangeal joint, forming a "V." Make the incisions deep, including subcutaneous tissues and fat.

Step 3. Dissect back the flap thus outlined. Sever diagonally the inner fasciculus of the plantar fascia. Divide the contracted structures in accordance with Phelps' procedure. Avoid injury to the astragalo-scaphoid capsule.

Step 4. Make similar incision on the outer side of the foot over the head of the astragalus. Divide the neck of the bone with a chisel. If necessary, remove the head. Overcorrection is thus facilitated. Ligate the bleeding points. Replace the triangular flap. Use perforated oiled silk to cover the wound which is not sutured. Dress. Apply a plaster of Paris cast about one third the length of the thigh. Dressings should not be changed for five or six weeks.

Brackman Open Operation

Step 1. Apply a tourniquet to the limb. Make an incision along the outer side of the foot along the calcaneus. Detach the plantar muscles and fascia from their origins as far backward and forward as possible.

Step 2. Make similar incision on the inner side of the foot; detach the muscles

completely. Identify the tendon of the tibialis posterior. Detach it from the tubercle of the navicular.

Step 3. Dissect the soft tissues off the inferior surface of the tarsal bones until all of the inferior and medial surfaces of the navicular and medial surface of the cuneiform (as) are exposed.

Step 4. Mobilize the navicular by dividing the ligaments on its medial surface as well as on its inferior and superior aspect. If necessary, divide the deltoid ligament of the ankle and the calcaneo-navicular ligament. Manipulate the foot bringing the navicular in front of the head of the talus.

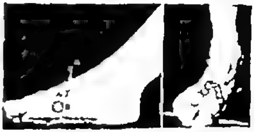


Fig. 776. Fig. 777.

Fig. 776. Skin incisions or operation for hallux valgus: lateral aspect.
Fig. 777. Skin incisions or operation for hallux valgus: dorsal aspect.

Step 5. Close the incisions and apply plaster with the foot not quite corrected. Two weeks later secure complete correction after removing the plaster and manipulating the foot without removing the sutures. If necessary, tenotomize the tendo calcaneus.

Step 6. Apply a second plaster cast for about eight weeks. After that, fit the patient with an ordinary boot and permit him to walk. Advise him to wear a club-foot splint at night. Attention should be given to exercising and teaching the patient to walk properly.

HALLUX VALGUS (BUNION)

(See also Excision of the head of the metatarsal bone of the great toe p. 7[illegible].)

The bony deformity of hallux valgus consists of extreme abduction of the great toe (Fig. 776). Such a condition results in the malposition of the other toes especially the second which may be over or under the laterally directed great toe. The distal and medial portion of the first metatarsal bone is subjected to constant trauma with the resulting formation of callus, an adventitious bursa (bunion) and exostosis.

The deformity is provoked by tight, ill-fitting shoes and gives rise to symptoms of pain, swelling and redness which may be complicated by a bursitis, arthritis or synovitis. Curative treatment is surgical and is designed to relieve pain, correct deformity and restore function (Fig. 777).

Operative Treatment of Hallux Valgus

This procedure is especially designed to relieve pain and diminish deformity.

Step 1. Make a dorsal, lunar incision extending upward from the base of the proximal phalanx to the midportion of the shaft of the metatarsal bone. Skin retraction makes it possible to dissect out the adventitious bursa and to expose the exostosis present on the metatarsal under local or general anesthesia (Figs. 776-777).

Step 2. Saw or chisel the bony deformity away until the lateral surface of the metatarsal bone is aligned with the foot.

Step 3. If, after this procedure, the deformity cannot be manually corrected perform a tenotomy upon the extensor tendon opposite the metatarsophalangeal joint.

Step 4. Carefully close and dress the wound. Place the toe in a slightly overcorrected position.

Step 5. Begin massage and voluntary motion after one week and permit weight bearing in three or four weeks.

Mayo's Operation for Bunion

In order to avoid the stiffness which he considers results from excision of the head of the metatarsal, C. H. Mayo operates as follows.

Step 1. Reflect a flap of skin downward on the inner side of the metatarsophalangeal articulation, avoiding injury to the bursa.

Step 2. Make a flap of the subjacent soft parts with its base at the root of the great toe. Reflect this flap together with the bursa.

Step 3. Correct the valgus by excising the head of the metatarsal; remove any bony excrescences.

Step 4. Turn the flap containing the bursa into the space between the metatarsus and the phalanx and suture it there.

Step 5. Pull the dorsal flexor tendon of the great toe around so as to lie over the middle of the toe joint and suture its sheath in this position.

Step 6. Close the wound and apply alcohol dressings to its surface and between the first and second toes.

The Radical Cure of Hallux Valgus (Baron's Operation)

SUBARTICULAR RESECTION OF THE HEAD OF THE METATARSAL BONE

The technic to be described, although perhaps slightly more difficult to do than some of the others, has the advantage of preserving the articular surface of the metatarsal bone at the same time it corrects the deformity. The aim is, therefore, to obtain an anatomically normal articulation and functional efficiency.

Step 1. The head of the metatarsal bone is exposed and the periosteum from the middle of the metatarsal bone to about one-quarter of an inch of the articular surface is incised (Fig. 778[1]).

Step 2. With a sharp thin periosteum elevator the periosteum is separated around the bone (Fig. 778[1]).

Step 3. The articular surface is detached from the bone (Fig. 778[2]). This can be done very easily and without damage if some bone is left attached to the articular surface itself; the spongy bone offers little resistance to sharp instruments.

Step 4. The head of the metatarsal bone is removed (Fig. 778, A), sufficient bone being cut away to straighten the big toe.

Step 5. The excess of skin is removed with the bursa, and the wound is closed (Fig. 778, B). A splint is applied and the wound dressed with gauze impregnated with glycerine or alcohol. The toe is kept at rest until all inflammation has subsided. Passive and active movements are then started.

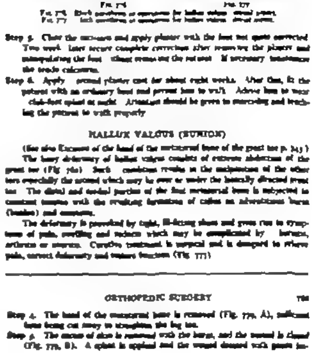


Fig. 778. Baron's operation for hallux valgus. (Courtesy Dr. A. L. Baron.)

Comment. By this technic, it is seen that, the periosteum and articular surface are separated from about half of the metatarsal bone. When the head of the bone is resected, the articular capsule with its synovia and periosteum falls back and covers the rough surface of the resected [illegible] which it will [illegible] short time adhere. Thus, while the head of the met[illegible]

bone has been removed the articular surface has been preserved. As a matter of fact, the relations between the distal phalanx and the metatarsal bone have been reconstructed to conform to normal anatomic standards. The only difference between the unoperated phalangometatarsal bones and its articulation is that in the latter the metatarsal bone is shorter.

HAMMER TOE (DIGITUS MALLEUS)

Hammer toe is characterized by dorsiflexion of the proximal phalanx, plantar flexion of the second, and flexion or extension of the distal. The interphalangeal joint is thus subjected to trauma from the shoe cap which produces an area of keratosis beneath which a bursa usually forms. The tip of the toe is pressed against the sole of the shoe producing callous formation and flattening (Fig. 780).

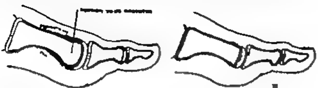


Fig. 779. Stone operation for hallux valgus. (Courtesy Dr. A. L. Stone.)

The condition most frequently involves the second or third toes. It is often bilateral and is usually caused by short shoes which crowd the digits. Congenital cases are seen, however, and any degree of pes cavus or of equinus tends to produce this deformity. Hallux valgus is often associated with the condition.

The patient complains of deformity, painful corns or bunions and difficulty in walking. Treatment in the young consists of manipulation and postural correction. In adult cases operative procedures are indicated.

Operations

Procedure 1. Tenotomy of the extensor digitorum longus and brevis through a slightly lateral incision just proximal to the interphalangeal articulation.

Procedure 2. Amputation of the toe (in the case of the second and third) through the proximal phalanx distal to the insertion of the interossei muscles with approximation of the extensor and flexor tendons. This procedure is not to be carried out in the presence of hallux valgus.

Procedure 3. A semilunar incision over the dorsum of the affected joint exposes the underlying bursa which is excised along with the reflected semilunar skin flap. The head and a portion of the shaft of the proximal phalanx are carefully exposed and excised. The skin is closed and the toe fixed on a splint in its proper position (Fig. 781).

INGROWN TOENAILS

There are few cases of ingrown toenail which will not respond to medical measures if much time and perseverance are used. The most popular method con-

sists of inserting a piece of cotton under the edge of the nail once or twice daily and then reducing the thickness of the nail to that of an ordinary piece of paper,

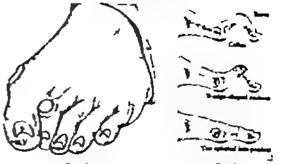


Fig. 780 Fig. 781
Fig. 780. Hallux valgus with bunion formation associated with digitus malleus.
Fig. 781. Surgical treatment of digitus malleus.

by rubbing it with pumice stone. Caustic may be applied to the protruding edges of nail, to the ulcerated area. Caustic soda solution is as is used to soften the nail.

If surgery seems advisable, Watson Cheyne's method is recommended. Local anesthesia usually suffices (Fig. 783).

Fig. 782. Deep infiltration for the control of ingrown toenails.

Step 1. Make an incision along the nail-fold down to the matrix, thus forming a flap along the side of the ingrowing nail.

Step 2. Remove a little less than half of the nail and all of the ulcerated tissue, care being exercised to see that the excision has completely destroyed the nail-fold. The operation will be unsuccessful unless this is accomplished.

Step 3. Place the flap on a level below the nail and insert one or two sutures (Fig. 783).

If it becomes necessary to remove the ingrown toenail, it is better to remove it from its bed entirely than to split it as the latter procedure results in a misshapen nail.

SYNDACTYLISM

Syndactylism is the partial or complete fusion of two or more fingers or toes. It is usually congenital, frequently bilateral and may vary from a thin membranous web to actual osseous union between the affected digits (Figs. 784-785).

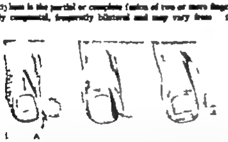


Fig. 783. Watson-Cheyne operation for ingrown toenail. For description see preceding page.

Surgical treatment is resorted to as early as the first year in order to conserve function, improve cosmetic aspects and prevent growth distortions (Fig. 786).

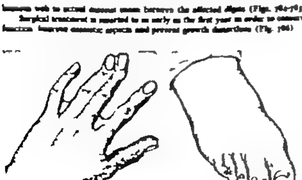


Fig. 784 Fig. 785
Fig. 784. Syndactylism of the hand associated with resulting growth deformities. Note the unequal webbing.
Fig. 785. Syndactylism of the foot associated with supernumerary digit.

Operations

Procedure 1. When a short web is present or very little soft tissue available, Agnew's procedure is the one resorted to. A generous v-shaped dorsal flap is raised and reflected. The uniting web is divided, hemostasis provided and the flap brought between the fingers and onto the palmar surface of the hand where it is sutured. The denuded area that remains is allowed to granulate in or a skin graft is applied (Fig. 787).

Procedure 2. When sufficient soft tissue is available, Didot's operation is used. One web at a time is corrected. Dorsal and ventral full thickness skin flaps with their bases on opposite fingers are carefully raised. The fused fingers are then separated and the skin flap attached to each is brought around and sutured into place. Gangrene not infrequently follows this operation, thus the vascular supply should be disturbed as little as possible (Fig. 788).

Fig. 788. X-ray of fetal hand.

When a small amount of soft tissue separates the digits which are extensively fused, the Didot operation may be preceded by the Agnew procedure. Complete separation is then effected six weeks later. Cases with short, soft tissue webs may be treated with a crushing clamp (Woolsey). Under local anesthesia a hemostat is clamped onto the web and there held in place for one or two weeks. Amputation is usually practiced when the toes are painfully involved.

OSGOOD-SCHLATTER DISEASE

Osgood and Schlatter in 1903 described a painful condition resulting from the partial separation of the epiphysis of the tuberosity of the diaphysis of the tibia. The disease usually occurs between the ages of 9 to 16 and is probably the result of trauma. Frequently a painful subpatellar

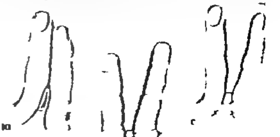


Fig. 787. Agnew's operation for syndactylism. Line of incision for dividing web. V-shaped dorsal flap prevents recurrence. Denuded area to be filled in by granulation.

bursitis is present. Radiographically the epiphysis shows anterior separation from the diaphysis, irregularity of contour (osteochondritis) and in some cases, fragmentation.

The disease has an insidious onset. The patient may first complain of an aching over the epiphyseal region following overexertion or trauma. There is local heat, tenderness, redness, swelling and limitation of movement, especially that of flexion. The condition may be bilateral and in every case both knee regions should be studied. The disease is self-limited and terminates spontaneously although fixation expedites recovery.

Treatment. Treatment consists in fully extending the knee and fixing it in plaster for four weeks. Weight bearing is allowed, immediately. Later the

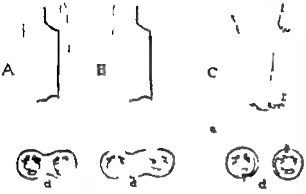


Fig. 788. Joint ... [illegible] ... C ... [illegible] ... d-d-d ... [illegible]

patient wears ... step-joint to prevent undue flexion. Exercise and complete flexion are not permitted until after four months have passed.

OPERATIONS ON THE JOINTS

ARTHRECTOMY

The complete or partial excision of a joint is indicated in a number of conditions, viz.

1. In tuberculosis or other severe disease involving a joint which is not improving under ordinary palliative treatment.

2. When the joint surfaces have become ankylosed, fixing the joint in an undesirable position or rendering it useless owing to immobility. This indication stands both for fibrous and bony ankylosis especially when a movable joint is imperative for occupational functioning.

3. In certain types of joint traumatisms in which there has been much comminution of the bone forming part of the joint and the fragments cannot be replaced sufficiently to restore good function.

4. In cases of exchondroses or exostoses of the articular extremities of long bones which extend into the joint cavity and make the articulation practically useless.

5. In some forms where the intra-articular cartilages are so displaced or torn that they cannot be replaced in suitable position and can only be satisfactorily dealt with by removal.

A joint may be excised by different modes. These are known as (a) the open method; (b) the subperiosteal or subcapsular method; (c) the osteoplastic method.

In the first, or open method, an incision is made through the soft tissues overlying the joint in order to expose the diseased tissues and facilitate their removal. On reaching the capsular ligament, the soft tissues are turned aside and the ligaments, together with the articular extremities, laid bare. The periosteum is left attached to the bones and the joint is excised either in whole or in part according to the extent and nature of the diseased portion.

In the second or subperiosteal (subcapsular) method of excising a joint, the periosteum covering the upper portions of the bones forming the joint, as well as the capsular ligament with its localized thickenings, are turned aside at the same time as the more superficial soft tissues; the diseased synovial membrane and articular surfaces of the bones are removed and finally the periosteum and the capsular ligament are replaced in their former positions. To effect this, the first incision is prolonged through the capsular ligament and the periosteum with which it is continuous and then with a rugine or a periosteal elevator these structures are stripped from their attachments and turned aside exposing the interior of the joint cavity thus enabling all diseased synovial membrane and articular cartilage to be removed. This procedure may rank only as a partial excision of the joint and is applicable to cases of joint disease in which the synovial membrane and the articular cartilages are alone involved, which is usually the case in early joint tuberculosis and certain types of traumatisms and their results. The subperiosteal-subcapsular method is not applicable in extensive joint disease when the periosteum must be removed.

In the third method of joint removal—the osteoplastic method—in addition to turning aside the periosteum of the articular extremities of the bones and the ligaments, an attempt is made to detach temporarily all bony prominences with the muscles and ligaments still fixed to them. The joint is exposed, as in the previously described method, and with a chisel and mallet the portions of the bones to which the muscles and ligaments were attached are cut through and turned aside together with their attached soft tissues. The diseased tissues in the interior of the joint are then removed, bony projections are then again fixed in their original positions by means of bone or ivory pegs or by wire sutures. This mode of arthrectomy is best employed in some cases of ankylosis and in severe traumatic affections of the joints.

We will now proceed to consider the technic of excision of some special joints.

Excision of Shoulder Joint

Step 1. The patient is placed in the dorsal position with the affected shoulder somewhat raised from the table and projecting slightly over the edge of the table, the limb being slightly abducted and rotated outward.

Step 2. An incision is made, commencing at the lower margin of the clavicle opposite the lateral border of the coracoid process and extending distally in a direction parallel to the anterior margin of the deltoid muscle for a distance of about 3 or 4 inches (Fig. 789). This incision is made over the medial fibers of the deltoid muscle, thus avoiding injury to the cephalic vein and accompanying artery which lie in the groove between the deltoid and pectoralis major muscles. Do not attempt to retract these two muscles but

Fig. 789.

Fig. 790.

Fig. 789. Excision of the shoulder joint (von Langenbeck method) ... deltoid muscle, ... long head of biceps tendon.

Fig. 790. Excision of the shoulder joint (von Langenbeck's method). Detachment ... the lesser tuberosity of the humerus. A, periosteum and capsule of shoulder joint; ... tendon of biceps muscle.

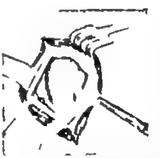
dissect down through the medial fibers of the deltoid muscle and locate the long head of the biceps muscle.

Step 3. The pectoralis major muscle is divided transversely at its clavicular attachment, if necessary in order to obtain a clear and unimpeded view of the shoulder joint. When the muscles are retracted the capsular ligament will be visible in the bottom of the wound (Fig. 790). The humerus is rotated so as to bring the intertubercular groove and the long tendon of the biceps brachii into view.

Step 4. The biceps tendon is separated from its sheath by dividing the capsular ligament along the lateral margin of the tendon together with the transverse humeral ligament; the tendon is retracted medially and the humerus rotated laterally bringing forward its small tuberosity with the insertion of the subscapularis, the latter being then separated from the bone.

Step 5. The humerus is now rotated medially so as to expose its large tuberosity and attached muscles which, as in the case of the small tuberosity

are separated from bone connections (Fig. 791). When the head of the humerus together with as much of the shaft as is requisite have been exposed, the proximal extremity of the bone is forced out of the external wound and sawn across distal to the diseased area, the margins of the cut being rounded off so as to make an artificial head to the bone (Fig. 792). If there are any other diseased centers in the vicinity they are removed by bone forceps or by a sharp spoon.



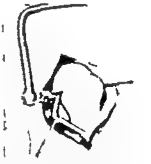


Fig. 791.

Fig. 792.

Fig. 791. Excision of the shoulder joint (von Langenbeck method). Detachment of greater tuberosity of the humerus.

Fig. 792. Excision of shoulder joint (von Langenbeck method). The head of the humerus has been delivered into the wound. The line of section of the head of the humerus by means of a Gigli or other appropriate saw is indicated by the dotted line.

Step 6. The external incision is closed following a thorough irrigation of the joint area and the placing of a drainage tube. If all goes well, passive movements of the limb may be begun about 10 days after the operation.

OPERATION FOR PROMINENT SCAPULA (SCAPULA ALATA)

This condition is due to a paralysis of the serratus magnus and the rhomboid muscles.

Pierre Duval's Operation[1]

Step 1. Make an incision along the vertebral border of the scapula beginning at the level of the scapular spine and extending downward to its angle.

Step 2. Divide the trapezius and rhomboideus major muscles to the entire extent of the wound. Retract the latissimus dorsi muscle strongly downward.

Step 3. Incise the periosteum along the exposed border of the scapula. Reflect it from the bone for a distance of about one-half inch together with infraspinatus muscle.

[1] Revue de Chir., 1905, 80.

Step 4. Separate the periosteum together with the serratus magnus muscle from the anterior surface of the scapula.

Step 5. Excise the periosteum and the serratus magnus muscle sufficiently to allow the denuded anterior surface of the scapula to lie freely in contact with the sixth and seventh ribs.

Step 6. Denude the sixth and seventh ribs of their periosteum about two and three-quarters inches from the midline. The seventh rib should be denuded about one half inch farther outward in order to afford the scapula proper obliquity.

Step 7. By means of two wire sutures, the scapula is sutured to the ribs.

Step 8. Wherever possible the periosteum should be sutured over the wires.

Step 9. By means of strong retraction of the medial edge of the wound comprising skin, trapezius and rhomboid muscles, expose the long muscles of the back which are situated on the posterior surface of the transverse processes at the upper angle of the wound.

Step 10. Fashion a long, thick flap, with its pedicle below, from the long muscles of the back. This flap should be sutured at the superior angle of the scapula to the periosteum and the supraspinatus muscle.

Step 11. Close the wound without drainage. Dress. Put a plaster of Paris corset on the patient for about 48 hours.

Mauclaire' Modification of Dowd' Operation[1]

Step 1. Separate the periosteum from the fifth, sixth and seventh ribs. This separation is carried out about nine centimeters from the midline of the fifth rib, ten centimeters of the sixth and eleven centimeters of the seventh. The purpose of this is to create a line of attachment of the scapula which will be oblique, from above downward and outward, the purpose being to raise the acromion process.

Step 2. Separate the periosteum around the ribs.

Step 3. Surround the ribs with appropriate sutures. Proceeding in this manner will prevent compression of the intercostal nerves.

Step 4. Suture the superimposed structures as in Dowd's operation.

Step 5. Suture the skin wound.

Step 6. Apply an apparatus (Mauclaire's) which will fix the arm in an elevated position with the hand resting on top of the patient's head. Continue the immobilization for 15 days, following which passive and active motions are begun.

SURGICAL TREATMENT OF CONGENITAL ELEVATION OF THE SCAPULA

V Putti's technic is described by O Scaglietti (Chir. del org. di Mov. Vol. 1, N. 4, 1933) as follows:

Step 1. Make an incision along the vertebral margin of the scapula (Fig. 793(1)).

Step 2. Detach the trapezius muscle and the latissimus dorsi.

Step 3. Free the rhomboids from the vertebral margin of the scapula by subperiosteal dissection (Fig. 793(2)). The scapula now is almost completely freed from its muscular attachments to the trunk. In many instances, it is necessary to remove a hook-like protrusion of bone which is frequently

[1] Technique Mauclaire, Paris Med., August 7, 1920.

found growing from the upper inner angle. When present, this must be removed (Fig. 793(3) and 4)), otherwise the scapula cannot be successfully drawn down to its normal level. By the use of retraction, the scapula is drawn as low as can be successfully done without disruption of the shoulder girdle.

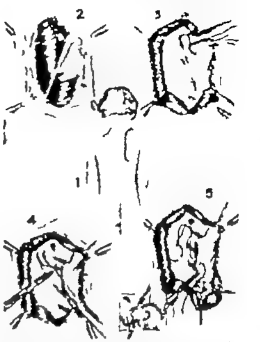


Fig. 793. Putti' operation for congenital elevation of the scapula. [illegible]

Step 4. Pass several sutures of braided silk to fix the scapula to the sixth or seventh rib, depending on how low the scapula can be drawn (Fig. 793(5)). An additional number of silk sutures are passed through the vertebral margin of the scapula and are fixed to the periosteum of the nearby ribs as illustrated.

Step 5. After the scapula has been firmly fixed, the cut muscles are approximated as closely to their former attachments as possible.

Step 6. A plaster cast is applied, the elbow flexed at right angles, the forearm in mid-pronation. Longitudinal traction must be applied to the arm so as to keep the scapula as low as possible. The sutures are removed at

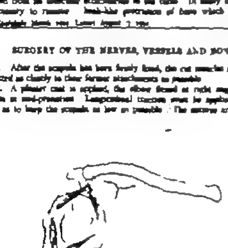


Fig. 794. Operation for subacromial bursitis (Codman). [illegible]

the end of 15 days at which time the cast has been opened. A new brace cast is applied immobilizing the chest and the arm so that graduated massage and exercises may be given. At the end of five or six weeks, the brace cast is discarded.

Comment. Early surgical treatment is most essential. The operative technic is varied, depending upon the anatomic features (either by bony or muscular contractures). Careful roentgenographic examination is necessary in order to detect whether or not any hook-like formation is present

over the upper inner portion of the scapula. Surgery is recommended immediately after diagnosis and after the correct evaluation of the operative risk in the young patients.

OPERATION FOR SUBACROMIAL BURSITIS (CODMAN)

Step 1. Make an incision about two to two and one-half inches in length beginning at a point midway between the coracoid process and the acromion process running parallel with the fibers of the deltoid muscle (Fig. 794).

Step 2. Split the deltoid muscle and enter the affected bursa.

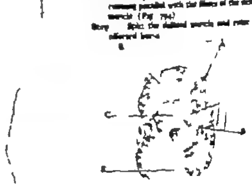


Fig. 795. Fig. 796.

[illegible]

Step 3. Excise the pathologic portion of the bursa.

Step 4. Hemostasis should be perfect. Suture the wound in the deltoid muscle with catgut sutures.

Step 5. Close the wound in the skin.

Comment. Motion is begun after about two days.

EXPOSURE OF THE SHAFT OF THE HUMERUS

Arnold K. Henry's Technic[1]

Step 1. With the patient's arm resting close to his side, the elbow extended and flexed by an assistant when necessary, an incision is made which commences above, over the coracoid process and extends along the course of the

[1] Brit. Jour. Surg., Vol. XIII, 1925.

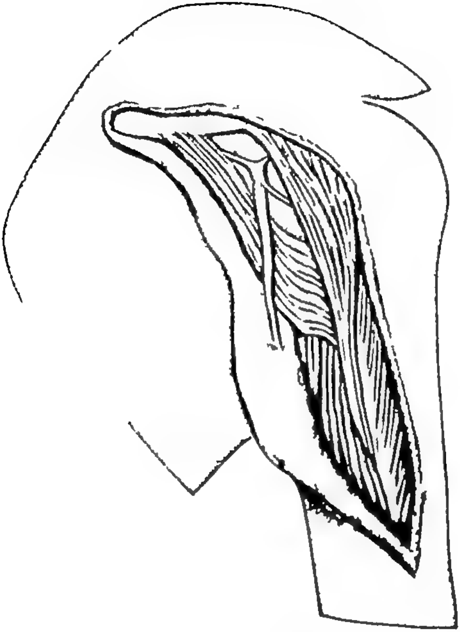


Fig. 801 The internal lip of the skin and fat tissue section is shown displaced internally leaving the clavicle in view also Mohrenheim's triangle and the cephalic vein which passes above the terminal part of the pectoralis major muscle (Gutierrez)

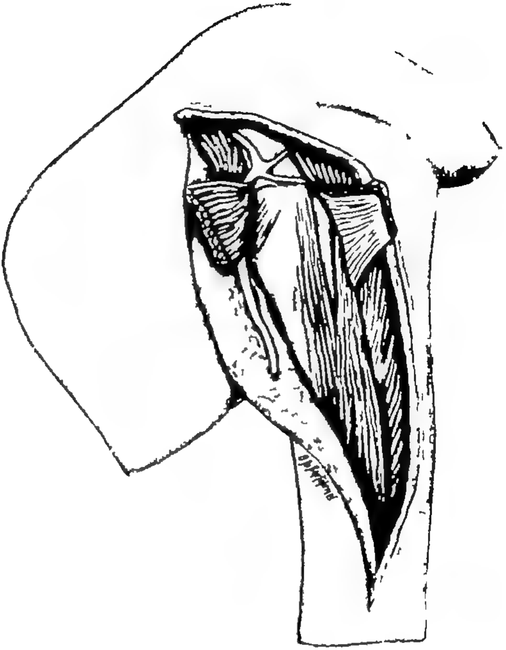


Fig. 802. Pectoralis major muscle is sectioned vertically giving exposure of the biceps muscle (Gutierrez)

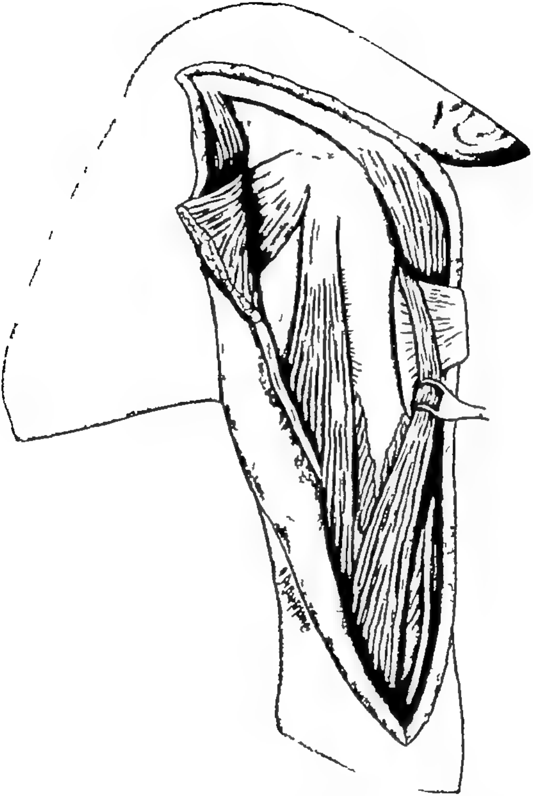


FIG. 803. The two parts of the biceps are separated exposing the upper portion of the humerus the upper part of the anterior brachial muscle i shown sectioned the radial nerve is seen (Gutierrez)

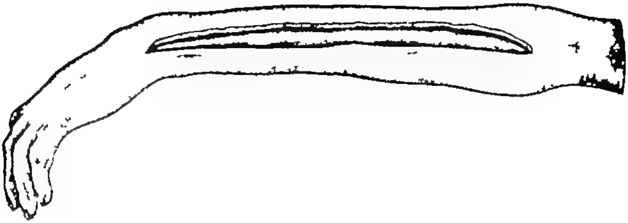


Fig. 808. Line of cutaneous olecranocubital incision (Gutierrez)

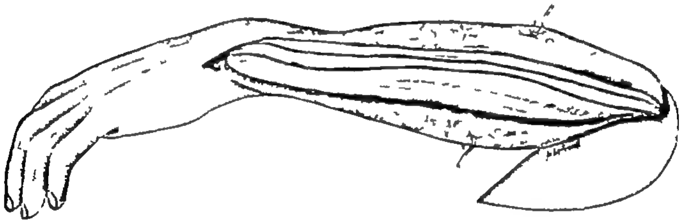


Fig. 809. The antebrachial aponeurosis is shown, divided longitudinally (Gutierrez)

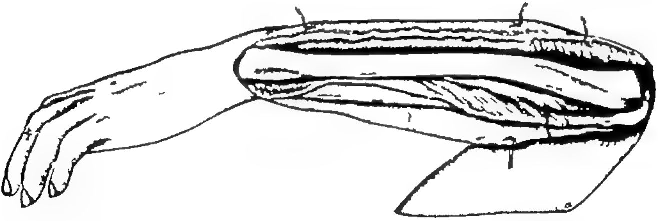
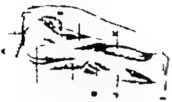


Fig. 810 Periosteum divided, making access to part easy (Gutierrez)



cephalic vein (Fig. 795). The course of this incision is obliquely outward along the inner margin of the deltoid muscle as far as its insertion, and then proceeds vertically downward along the outer border of the biceps muscle a short distance below the head of the elbow.

Step 2. Continue the incision down to the bone along the exposed margin of the deltoid muscle.

Step 3. Split the brachialis anticus muscle longitudinally in the direction of its fibers and direct it to reach the humerus at its rounded anterior border so as to avoid brachial ... (Fig. 796). Leave a substantial layer of muscle tissue to protect the musculo-spiral nerve (Fig. 797). Flexing the elbow now renders the lower part of the bone widely accessible. In order freely to expose the upper part of the shaft of the humerus, its tuberosities and head,

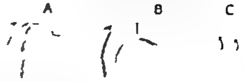


Fig. 800. Henry's method of exposure of the shaft of the humerus. Cut the leopard ... from the clavicle along the ... and ... the deltoid muscle and ... the leopard ... the deltoid origin. By means of two sutures, tie the ... back into its original position.

der, Henry advises to continue the upper end of the skin incision outward along the upper surface of the clavicle to the acromioclavicular joint. Reflect the skin and fascia so as to expose the origin of the deltoid muscle (Fig. 799).

Step 4. Detach with a chisel the edge of the bone carrying the insertion of the deltoid muscle continuing the detachment as far as the acromioclavicular joint (Fig. 800). The deltoid muscle can now be turned outward on the hinge of muscle and bone thus produced, affording a clear view to the underlying structures (Fig. 800).

Step 5. When the operation is completed, pass sutures through the muscle and around the clavicle thus drawing the bone back into position and reconstituting the deltoid origin.

Comment: Mason's incision is simpler one but Henry's affords better exposure of the head of the humerus and its tuberosities as well as the other parts of the bone.

SURGICAL EXPOSURE OF THE HUMERUS

Gutierrez Technic

Gutierrez is of the opinion that surgical exposure of the humerus is best made by the anterior route. On studying the anterior route, by which the bone ... from ... over ...

can be reached without compromising vascular or nerve elements of importance there are two alternatives: one antero-external or transpectoral, the other the pectorodeltoidean.

I. Antero-external or Transpectoral Method

Step 1. Make a cutaneous incision starting from the middle part of the clavicle, extending first in the direction of the deltoid-pectoral sulcus and, then, the external border of the biceps muscle, until the middle of the elbow region is reached (Fig. 801).

Step 2. Widen the muscle interstice between the major pectoral and deltoid muscles, expose the tendon of the pectoral for some ... cm, divide the base of its attachment. The external or anterior lip of the biceps is exposed and divided vertically (Fig. 802). This exposes the biceps in two parts; widen the interstice between the two and retract the large part. This exposes the humeral head and surrounding part of the bone. Under this is seen the upper part of the anterior brachial muscle (Fig. 803).

Step 3. Retract the large part of the biceps outward, exposing the most external part of the anterior brachial and divide it longitudinally. The humeral diaphysis and inferior articular portion are also exposed (Fig. 804). Divide the articular portion, thus exposing the anteromedial part of the head of the humerus. Opening the elbow articulation exposes the condylar parts of the humerus (Fig. 805).

II. The Antero-external or Interdeltoid Pectoral Method

The line of cutaneous incision is similar to that previously described. The soft parts are sectioned and the cephalic vein either ligatured or drawn aside (Fig. 806).

SURGICAL EXPOSURE OF THE ELBOW

Gutierrez Technic

Step 1. Make a straight incision extending from the most prominent point of the olecranon process to the distal extremity of the ulna (Figs. 807-808).

Step 2. Divide the aponeurosis of the forearm longitudinally over the bony surface of the ulna (Fig. 809).

Step 3. Split the muscles of the ulna from its superior to the inferior extremity. Divide the periosteum (Fig. 810).

The exposure of the parts are easily effected owing to the direct relationships of the ulna to the skin.

RESECTION OF THE ELBOW JOINT

This joint may be excised completely or partially according to the circumstances.

Step 1. The patient is in the dorsal position and the affected arm is ... flexed at the elbow and resting upon the trunk.

Step 2. Make an incision, about ... inches or more in length, commencing on the dorsal aspect of the forearm about ... inches distal to the elbow joint and extending proximally to a similar distance above, the prominence of the olecranon being opposite the middle of the incision (Fig. 8). The incision is carried down to the posterior aspect of the bone.

Step 3. A flap is made and turned up, the upper part consisting of the lateral aspect of one-half of the triceps brachii muscle, the corresponding part of the olecranon and the origins of the extensor muscles which are attached to the lateral epicondyle of the humerus; the lower part of the flap includes the rest of the olecranon and the dorsal and ... of the extensor muscles.

Step 4. Turn up a similar flap on the medial side, care being taken not to injure the ulnar nerve lying in the groove upon the posterior aspect of the medial

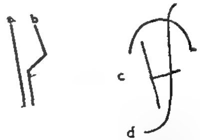


Fig. 8.. Excision of the elbow joint (after Bryant) ... Lateral ... incision, ... incision, C, incision of Langenbeck ..., D, Kocher's incision, E, Kocher's ... incision.

epicondyle of the humerus. Care must be exercised not to injure nerves. On the lateral side the lateral epicondyle, if not diseased, may be cut through with a chisel preserving as far as possible the attachments of the extensor muscles.

Step 5. Proceed similarly on the medial side subjecting the medial epicondyle to the same treatment.

Step 6. Flex the joint, cut through the posterior part of the capsular ligament close to the olecranon process and the joint cavity is opened exposing the bone extremities.

Step 7. The distal extremity of the humerus is now protruded, the trochlear portion grasped with forceps and sawed along a plane ... is above ... articular surface. The base of the olecranon together with the ... portion of the coronoid ... removed ... the saw as well as the ...

radius below the articular surface but above the attachment of the biceps tendon.

Step 8. The operative area is thoroughly examined for any other diseased tissues which can be scraped away with sharp spoon or dissected out with scissors.

Step 9. Termination. Close the wound. Insert drainage tube. Splint and bandage the arm in a semiflexed, semipronated position for at least a few days, following which passive movements are cautiously commenced.

Several different incisions have been recommended for excision of the elbow joint. Kocher's curved incision commences at a point opposite the upper part of the lateral supracondylar ridge of the humerus and extends distally along the lateral aspect of the limb as far as the head of the radius. It then crosses the anterior aspect of the forearm in an oblique direction to a point on the posterior border of the ulna about 3 inches distal to the elbow joint terminating by curving medially for a short distance.

SURGICAL EXPOSURE OF THE RADIUS

Gutierrez Technic[1]

Step 1. Make a straight incision extending from a little below the radial styloid process to the lateral epicondyle (Fig. 8[illegible]). Divide the skin and subcu-

Fig. 842. Surgical exposure of the radius (Gutierrez).

taneous fat (Fig. 843). In the lower part of the incision the cutaneous branch of the radial nerve is seen, passing above the tendons of the large abductor and short extensor of the wrist (Fig. 844). Incise the aponeurosis of the forearm over the muscles mentioned and continue the dissection to the lateral epicondyle.

Step 2. Widen the intermuscular interstice between the common extensor of the fingers and the second external radial thus exposed. A small part of the radial bone is seen in the lower part of the large abductor of the wrist between both muscles (Fig. 845).

Step 3. Separate the second radial from the common extensor reaching the deep muscle plane which is made up of the large abductor below and the short supinator muscle above. In the upper part the separation between the second radial and the common extensor must be made by the knife since at that level the muscles form a single mass.

Step 4. Divide the short supinator longitudinally exposing the postero-lateral surface of the radius in all directions (Fig. 846). In the upper part, the articulation of the elbow can be opened widely exposing the humero-radial articulation. The posterior branch of the radial nerve should be recognized before the short supinator muscle is sectioned.

[1] Revist. de cirug., Buenos Aires, Nov. 1931.

Fig. 843. The [illegible] surface of the radius is exposed (Gutierrez).

Fig. 844. A small part of the radius [illegible] (Gutierrez).

Fig. 845. Cutaneous branch of the radial nerve exposed (Gutierrez).

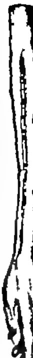


Fig. 846. [illegible] (Gutierrez).

EXPOSURE OF THE RADIUS OR ULNA

ARNOLD K. HENRY'S TECHNIC

Indications.

a. Tumors (especially myeloma)
b. Tuberculosis
c. Sequestra
d. Exposure for plate grafting, etc.

Step 1. Apply a tourniquet as high as possible.

Step 2. Extend the patient's elbow and fully supinate the forearm.

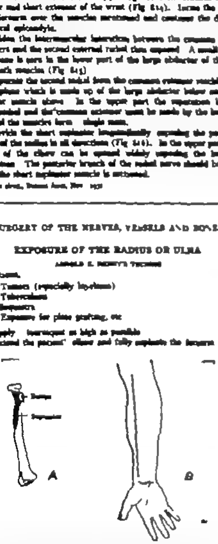


Fig. 847. Arnold K. Henry's method of complete exposure of the radius. A, Anatomical relationships of the upper part of the radius. The white interval between the two black areas represents the bicipital bursa and shows how [illegible] by the supinator edge. The surgeon [illegible] to the bursa by the outer face of the biceps tendon. B, Henry's incision in complete exposure of the radius. [illegible] from the lower end of the biceps belly to the end of styloid. [illegible] over the biceps tendon. (Redrawn from British Journal of Surgery.)

Step 3. Make an incision beginning about two inches proximal to the bend of the elbow at the outer border of the biceps muscle and ending below at the tip of the styloid process of the radius (Fig. 847B).

Step 4. Divide the deep fascia at the outer border of the tendon of the biceps and open the fascia to the entire extent of the wound.

Step 5. Retract outward the brachioradialis, the extensor carpi radialis longus, the extensor carpi radialis brevis muscles and the radial nerve; then retract the radial vessels inward (Fig. 848).

Step 6. Ligate and divide the recurrent radial vessels at the outer side of the biceps tendon.

Step 7. Flex the elbow to about 90° to relax the muscles. Retraction of the

Brit. Jour. Surg., Vol. XIII, p. 506.

muscles will bring into view the supinator brevis muscle as it embraces the upper third of the radius.

Step 8. Cut down on the radial tuberosity, keeping the knife close to the outer border of the biceps tendon and open the bicipital bursa (Fig. 848).

Fig. 848. Arnold K. Henry's method of complete exposure of the radius. Exposure of biceps tendon [illegible]. (Redrawn from British Jour. Surg.)

The knife, Henry points out, strikes the radial tuberosity where it lies in a bay formed by the supinator edge. From this strategic point the operator peels the supinator muscle off the bone. The muscle is turned outward, carrying within its substance the posterior interosseous nerve.

Fig. 849. Arnold K. Henry's method of complete exposure of the radius [illegible] the supinator [illegible] peeled off the radius. The [illegible] through the bursa. (Redrawn from Brit. Jour. Surg.)

Step 9. Detach the pronator radii teres and the pronator quadratus muscles and displace them inward. Pronation of the forearm at this stage of the operation exposes the radius in its entire length (Fig. 850).

Comment. The important phase of this operation is that the incision is placed between the flexor muscles which are supplied by the median nerve, and the extensor muscles as well as the supinators which are supplied

by the musculo-spiral nerve. Should it become necessary to expose the distal portion of the radius only, the lower half of the incision is sufficient. On the other hand, where the proximal end of the radius is to be exposed, the necessary exposure is obtained by resorting to the upper half of the incision.

Excision of the Radial Portion of the Proximal Radio-Ulnar Joint

When this excision is indicated and the location of the head of the radius is determined, an incision, [illegible] inches or so in length, is made over the projecting part of the bone, parallel to the long axis of the forearm and carried down to the bone. The articular ligament which surrounds the head of the radius is divided

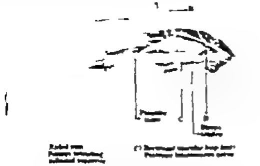


Fig. [illegible]. Arnold K. Henry's method of complete exposure of the radius. [illegible] (Redrawn from British Jour. Surg.)

and the soft tissues pulled aside with retractors. The radius is then cut through either with bone forceps or saw, the section being made above the tubercle of the radius, and care being taken not to injure the branches of the radial nerve.

EXCISION OF THE WRIST

This excision may be indicated in cases of tuberculous disease involving the wrist, in severe compound fractures and in certain inflammatory conditions. Of the many operative procedures that have been devised, the best appear to be those which are performed through dorsal incisions and of these the most satisfactory appears to be that of Ollier. Excision of the wrist by Ollier's method may be described as follows:

Ollier's Method

Step 1. Skin Incisions and Exposure of Bones. Two incisions are made, one on the radial, the other on the ulnar side of the dorsal aspect of the limb, using an Esmarch tourniquet on the arm to control bleeding.

Radial Incision. This commences on the dorsal surface of the second metacarpal bone at a point opposite the middle of the shaft and extends proximally along the lateral margin of the most lateral tendon of the ex-

tensor digitorum communis to a point situated at the center of a line joining the styloid processes of the radius and ulna (Fig. [illegible]). Beyond this level it is prolonged upward in a vertical direction for about one inch or so. The whole incision measures about 3 or 4 inches, one-third being situated proximal to the line joining the two styloid processes and two-thirds distal to it.

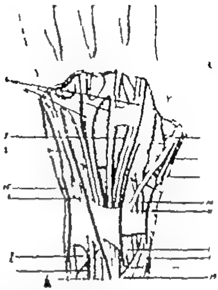


Fig. [illegible]. Ollier's operation of excision of the wrist-joint. [illegible]

The incision is deepened until the bones are reached, care being taken not to divide the tendon of the extensor carpi radialis brevis which is inserted into the base of the third metacarpal bone. The dorsal aspect of the bones is laid bare by detaching the posterior ligaments and the periosteum.

Ulnar Incision. This is made along the ulnar margin of the tendon of the extensor carpi ulnaris, beginning opposite the middle of the shaft of the fifth metacarpal bone and extending proximally to a point about an inch or so above the prominence of the styloid process of the ulna (Fig. [illegible]). The skin and soft parts are divided (avoiding the branch of the ulnar nerve) to the dorsum of the little finger as well as the muscles, which are retracted

exposing the dorsal aspect of the lower portion of the ulna, the cuneiform and unciform bones and the proximal part of the fifth metacarpal; the ligaments and periosteum are separated from their bony attachments.

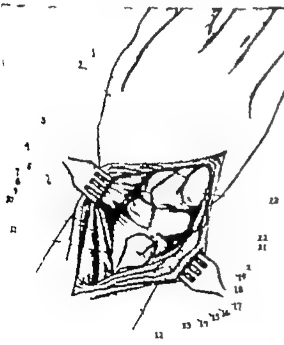


Fig. [illegible]. Excision of the wrist by the dorso-ulnar incision (after Kocher). [illegible]

Step 2. Excision of the Joint. When the carpal bones have been detached each is seized separately with forceps and removed (Fig. [illegible]). On the radial side the large trapezium bone should be left unless diseased. The articulation between this bone and the base of the first metacarpal bone separate

synovial membrane. The pisiform bone may be disarticulated and the hook of the unciform bone cut through and both left if not diseased. The shafts of the extremities of the radius and ulna are now cleared of their periosteum for about half an inch or so (according to the extent of the disease process) and then made to protrude through the lateral incision. The ends are sawed

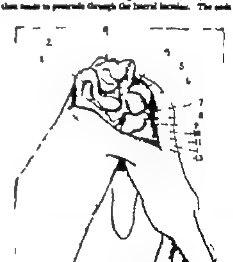


Fig. [illegible]. Excision of the wrist by the dorso-ulnar incision (after Kocher). [illegible] dorsal branch of the ulnar nerve [illegible]

off beyond the limits of the articular surfaces, or it may suffice to scrape them with a sharp spoon. The proximal extremities of the metacarpal bones are protruded through one of the dorsal incisions, usually the medial, and the articular ends sawed off.

Step 3. Closure of the External Wound. The cavity from which the bones have been removed is sponged dry, freed from all debris and the margins of the skin incisions united by interrupted sutures, a drainage tube left in.

The limb is fixed in a position of slight dorsiflexion with the hand, a splint of suitable shape being used. The fingers

moved after 48 hours and during the time that the splint is worn which may vary from three to six months. The splint should then be replaced by a leather wristlet.

EXCISION OF THE HIP JOINT

This excision is usually only partial, the femoral elements being the parts which are generally removed. The excision is mostly indicated for tuberculous disease, less frequently for ankylosis in a faulty position, or for inflammatory affections or traumatisms (Fig. [illegible]).

Excision of the hip joint may be carried out either through a postero-lateral incision or through an anterior incision, the first type being employed

Fig. [illegible]. Ankylosis of the hip joint.

for extensive operations. Whatever incision is employed, the important thing is to give access not only to the head and neck of the femur but also the acetabulum and lining of the capsule when the latter are diseased. The anterior route does not give access to the acetabulum, a difficulty which is overcome by the use of a modified Smith-Petersen incision.

Kocher's Method

This method gives good access to both bones and is usually preferable to any other.

Step 1. The incision, a modification of the external lateral incision: the upper half runs obliquely parallel to the fibers of the gluteus maximus muscle and practically to the axis of the head of the femur; this part of the incision extends from the posterior superior angle of the great trochanter

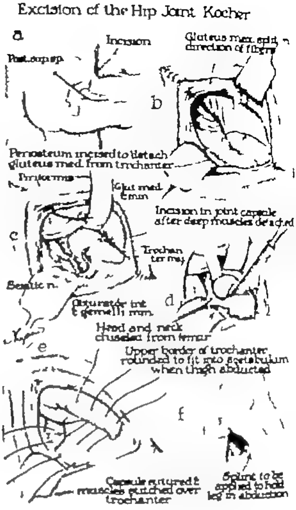


Fig. [illegible]. Excision of the hip joint (Kocher's method), [illegible] the illustrations [illegible] the legends with the text.

upward and backward toward the posterior-superior spine of the ilium (Fig. [illegible]). The lower half runs downward from the great trochanter in the axis of the femur slightly below the root of the greater trochanter.

Step 2. Divide the soft parts, split the muscles until the insertion of the vastus externus is exposed. Hemostasis must be carefully attended to here, applying ligatures or forceps to any divided vessels.

Step 3. This step in the operation consists in detaching the insertion of the gluteus medius muscle (Fig. [illegible], b). In a child this is easily done by using a resection knife and including a slice of the epiphyseal cartilage along with the tendon. In adults the operator must use either a sharp rugine or apply the hammer and chisel and detach a layer of bone with the tendon. When the insertion of the gluteus medius is separated, the insertion of the gluteus minimus is reached and, if necessary, this may also be detached from the anterior border of the trochanter.

Step 4. The insertions of the pyriformis, of the obturator internus and the gemelli are now detached from the trochanter. The posterior part of the capsule is now fully exposed (Fig. [illegible]) and, in cases of displacement of the femur, more or less of the head of the bone may project outside the acetabulum, the capsule being stretched over.

Step 5. The capsule is usually incised in the coronal plane over the projecting head of the femur. The opening is extended right up to the margin of the acetabulum and well down to the trochanter. By rotating the limb, the head of the femur is made to project through the opening. The ligamentum teres, if still present, must be separated from the femur either with a probe-pointed knife or by a curved scissors.

Step 6. The whole region of the joint should now be carefully investigated to ascertain the extent and nature of the disease process present. If necessary, removal of the head and neck of the femur may be called for. In fact, most authorities agree that, whether the head of the femur be much diseased or not, it is wiser to remove it, and the same generally applies to the neck of the femur. The saw or hammer and chisel may be employed (Fig. [illegible], d). If the disease extends into the trochanter, this latter should be curetted with a sharp spoon or the periosteum separated and the trochanter removed if it is absolutely necessary to do so.

Step 7. The acetabulum must now be investigated. Any diseased soft tissues should be removed. If the acetabulum is affected, the nature and extent of the disease process will determine the amount of the bone to be removed. The synovial membrane lining the capsule and any diseased spots in the exposed region should receive attention, widening the incision in the capsule if necessary.

Step 8. Remove all debris; thoroughly irrigate the joint cavity with antiseptic or sterile salt solution.

Step 9. Round off the upper border of the trochanter so as to make it fit into the base of the acetabulum when the limb is abducted.

Step 10. Unite the deeper structures over the trochanter by catgut sutures, (Fig. [illegible]) the capsule first, then the gluteus medius to the pyriformis and superior gemellus, and suture the edges of the split gluteus maximus with

catgut tied over a piece of fine rubber tubing to forestall too early cutting into the skin.

Step 11. The question of drainage is debatable. Unless an antiseptic has been employed in irrigating the joint cavity, drainage is perhaps better omitted.

Step 12. The hip must be kept in abduction (Fig. [illegible], f) by suitable splints during the whole period of after-treatment and every care should be taken to prevent the trochanter becoming displaced from the acetabulum. When the wound has fully healed, usually after about three weeks, a plaster of Paris cast is substituted for the splint, but no effort should be made to reduce the amount of abduction. The cast or splints may have to be worn for at least six months.

When the hip joint is excised through an anterior incision this is made on the antero-lateral aspect of the thigh, commencing above about ½ inches below the anterior-superior spine of the ilium and extending distally and medially until a total length of from 3 to [illegible] inches is reached. The deepened incision opens up the region between the sartorius and rectus on the medial side and the tensor fasciae latae and gluteus medius and gluteus minimus on the lateral side until the surface of the capsule is exposed. The capsule is incised and the interior of the joint opened. One is irrigated and any diseased parts of the femur sawed off, any other diseased spots are dealt with as in the previously described operation, debris removed and after irrigation the wound is closed up and a drain left in. The further treatment is similar to that followed in the case of a postero-lateral incision.

OPERATIONS ON THE PELVIC BONES

Excision of the Ilium

[illegible]

Step 1. Make an incision beginning at the anterior superior spinous process of the ilium. Extend it downward along the anterior border of the tensor vaginae femoris and divide the deep fascia (Fig. [illegible]).

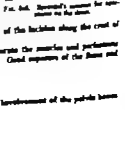


Fig. [illegible]. [illegible] incision for operations on the ilium.

Step 2. Divide the fascia and the origin of the gluteus medius and minimus muscles by cutting backward from the upper end of the incision along the crest of the ilium.

Step 3. Through the incision thus made separate the muscles and periosteum from the pelvis downward and backward. Good exposure of the ilium and part of the acetabulum is thus obtained.

Step 4. Perform the selected operation.

Step 5. Close the wound.

Comment. Where there is considerable involvement of the pelvic bones Lurgin's high curved incision is used.

Removal of Half of the Pelvis

Step [illegible] Begin the incision at the sacro-iliac synchondrosis and extend it forward along the crest of the ilium to Poupart's ligament.
Step [illegible] Divide the abdominal muscles attached to the crest of the ilium and to Poupart's ligament.
Step 3. Separate the transversalis fascia and peritoneum from the iliac fossa.
Step 4. Expose the iliac vessels. Retract these together with the nerve structures.
Step 5. Isolate and divide the muscles passing under Poupart's ligament external to the great vessels.
Step 6. Divide the rectus femoris, sartorius and tensor [illegible] femoris muscles.
Step 7. Separate the gluteus medius and minimus muscles by blunt dissection exposing the sacro-iliac articulation.
Step 8. Divide the ilio-psoas muscle and the capsule of the hip joint in front.
Step 9. Divide with [illegible] Gigli saw the horizontal ramus of the os pubis as well as the ramus of the ischium.
Step 10. Separate the sacro-iliac articulation and dislocate the bone downward.
Step 11. Separate the rest of the pelvic attachments by means of blunt and sharp dissection. Divide the fibers arising from the tuberosity of the ischium and the sacrosciatic ligaments.
Step 12. Excise the head of the femur.
Step 13. Remove the mobilized portion of the pelvis.
Step 14. Suture the abdominal muscles to the gluteal.
Step 15. Close the wound by means of deep and superficial sutures. Provide drainage.

Comment. According to Kocher bleeding is only moderate. He suggests it might be well to ligate the internal iliac vessels before extracting them.

Excision of the Symphysis Pubis

VON FRISCH'S OPERATION

Step [illegible] Make [illegible] transverse incision immediately above the os pubis.
Step [illegible] Separate the soft tissues. Divide the bone subperiosteally beyond the limits of the disease (Fig. [illegible]). Remove the affected bone.
Step 3. Close the wound. Drain.

Excision of the Acetabulum

KOCHER'S OPERATION

Step [illegible] Through [illegible] Langenbeck incision open the hip joint.
Step [illegible] Dislocate the head of the femur and, if necessary, excise it.
Step 3. Adduct and rotate the limb outward.
Step 4. Make an incision beginning at the middle of the wound cutting across at right angles toward the anterior inferior spine of the ilium. Carry this incision downward to the bone.
Step 5. Separate from the ilium, by means of blunt dissection, the periosteum and superimposed soft tissues above the acetabulum extending from the anterior inferior spine to the sciatic notch.

Step 6. Divide the ilium transversely above the acetabulum by means of chisel and mallet (Fig. [illegible]). Exercise care not to injure the pelvic contents. Divide the horizontal ramus of the os pubis with [illegible] Gigli saw.
Step 7. Separate the soft parts from the ischium below the acetabulum with periosteal elevator.
Step 8. By means of [illegible] Gigli saw or chisel divide the ischium.
Step 9. Grasp the separated acetabulum with powerful bone forceps and remove it. Any ligamentous, muscular or osseous connections are divided with scissors.

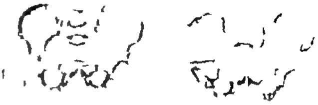


Fig. [illegible] Fig. [illegible]
Fig. [illegible] Excision of pubis [illegible]
Fig. [illegible] Excision of acetabulum (Schmidt)

Step 10. Close the wound. Drain.
Step [illegible] Put up the limb in marked abduction.

EXPOSURE OF THE SHAFT OF THE FEMUR[illegible]

Arnold K. Henry's Technic

Step [illegible] Make an incision of the skin and deep fascia along [illegible] line beginning at the anterior superior spinous process of the ilium and extending to the outer angle of the patella (Fig. [illegible]).
Step 2. Find the line of cleavage with the finger between the rectus femoris and vastus externus muscle, [illegible] hand breadth below the great trochanter.
Step 3. Separate the muscles by means of the finger. Some blood vessels may be encountered which are ligated and divided. The finger may be stopped in the lower third of the thigh [illegible] here the aponeurotic fibers of the rectus tendon are encountered. Use the knife to separate these. In keeping the blade of the knife parallel to the line of the quadriceps tendon, [illegible] plane of cleavage will be found in this tridendate structure between the prolongations of the rectus and vastus muscles which will permit the separation of the structures down to the patella. In septic conditions be careful not to separate the [illegible] of the quadriceps tendon beyond [illegible] one hand breadth proximal to the apex of the patella. This will avoid infection of the synovial cavity of the knee (Fig. [illegible]).
Step 4. Draw the mobilized muscles strongly apart exposing the silvery surface of the crureus femoris muscle. The oblique descending branches of the [illegible] [illegible]

lateral circumflex vessels and the nerve to the vastus externus muscle are seen then passing across the crureus from beneath the rectus femoris to meet the low edge of the vastus externus muscle with which they cross.
Step 5. Retract the neurovascular bundle just described, proximally (Fig. [illegible]).

Fig. [illegible] Fig. [illegible] Fig. [illegible]

[illegible]

Step 6. An incision may now be made down to the bone through the upper portion of the crureus muscle. Frequently [illegible] large vessels are encountered here. Care must be taken not to injure the suprapatellar pouch. Such extends about [illegible] hand breadth above the apex of the patella. Operative [illegible] is easily avoided by not continuing the incision through the crureus muscle above that level. The raspatory adheres closely to the bone working in [illegible] layer of fat and separating the pouch from the femur. A retractor may be slipped between the suprapatellar pouch and the bone and [illegible] flex the thigh. [illegible] the quadriceps

[illegible] [illegible] thus affording access to the lower end of the shaft of the femur.
Step 7. When the two split halves of the crureus muscle are separated from the bone and retracted forcibly over [illegible] most of the shaft of the femur is exposed from the lower epiphysis to the lesser trochanter. On the inner side of the shaft the attachments of the muscles to the linea aspera are visible. If it becomes necessary to clear the linea aspera, note carefully the direction of the muscle fibers. The edge of the raspatory should travel into the acute angle [illegible] which the fibers make with the bone (Fig. [illegible]). If used in the opposite direction the instrument [illegible] tend to leave the bone and tear into the muscle. It is well to keep in mind that the direction of the muscle fibers varies, i.e., the adductors travel down to the femur while the vastus and the short head of the biceps travel down from the femur. Separation of the fibers should be

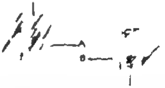


Fig. [illegible] Henry [illegible] method of exposure of the femur. [illegible] Raspatory [illegible] worked into the acute angle, A, which the muscular attachments form with the bone. [illegible] How the raspatory tears into muscle when used [illegible] the wrong direction against the obtuse angle.

begun on the inner side of the linea aspera on the external surface of the shaft of the femur. The raspatory is worked up against the origins of the vastus externus and the short head of the biceps muscle. Deal with the strong external intermuscular septum last. It can be exposed by drawing the vastus externus toward the back of the thigh. The perforating vessels emerge through the arched openings of the septum.

EXCISION OF THE KNEE JOINT

The knee joint may be completely excised and such an operation is usually required in extensive tuberculous disease, but by the term arthrectomy of the knee only [illegible] partial excision of the joint is usually meant. In the complete excision the surgical object [illegible] to obtain [illegible] firm bony union of the tibia and femur. In arthrectomy the surgeon aims to produce, if possible, [illegible] movable joint.

Step [illegible] Make [illegible] horseshoe-shaped curved incision (Fig. [illegible]) [illegible] across the front of the knee.
Step [illegible] Partial excision. Cut through the ligamentum patellae at the lower part of the incision, open the joint cavity from below by lifting up the ligament, patella and capsule of the joint (Fig. [illegible]).

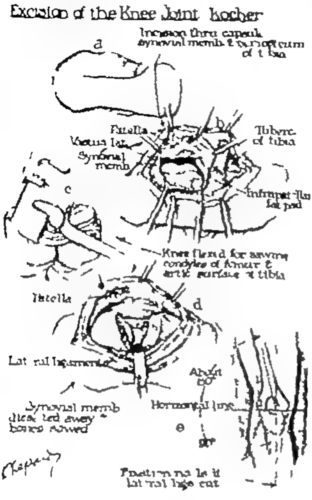


Fig. 8??. Excision of the knee joint.

Step 3. All thickened, synovial membrane is now scraped or dissected away (Fig. 8??, d); also the articular ends of the bones, if affected.

Step 4. The joint cavity is next thoroughly irrigated with normal saline or mild antiseptic solution.

Step 5. The ligamentum patellae and the margins of the incision in the capsule are united by the insertion of a series of silk or chromic catgut sutures.

Step 6. Close the external wound in the usual manner and put up the limb in a suitable splint. When the wound has completely healed, passive movements are begun and an attempt made to obtain a movable joint. (Fig. 8??.)

Some, such as Kocher, recommend a reversed U incision, as in the complete joint excision and that, after the skin flap and fascia have been dissected up, the knee joint should be opened on each side of the patella and all necessary manipulations carried out through that incision.

If there is extensive involvement, a greater amount of removal of the articular surfaces may be necessary. In order to do this, the crucial ligaments are divided which allows the joint to be separated from the femur and the lower end of the latter bone to be projected from the wound. The lateral ligaments are pushed aside or cut. The bone is now sawed through, the saw being so held that the plane of its blade corresponds with the transverse plane of the long axis of the leg when the joint is at an angle of 15 degrees. The head of the tibia is next cleared. It is usually only necessary to clear the extreme top of the plane so as to cut a level surface. This will remove most of the cartilage together with the semilunar cartilages and the projecting spine of the tibia. The saw is applied from before backward and its blade is held strictly horizontal. When the bone sawing has been done accurately the cut surfaces should fit exactly when applied together. The limb is then carefully splinted and bandaged so as to obviate bone displacement.

When only a portion of the articular surface is to be removed, the chief aim will be to retain the movements of the knee. The sawed surfaces where part of the joints have been removed should be left as smooth as possible and, to prevent union of the opposing raw joint surfaces, some kind of arthroplasty must be employed.

In the case of an excision for arthrodesis the object is to obtain a solid joint with the least amount of shortening. This can be done by merely removing the cartilage from the articular surfaces with a broad chisel or gouge. The joint is opened by a trans-patellar incision and the patella is sawn across. It is not necessary to disturb the ligaments.

In excision for ankylosis in a faulty position the external transverse incision should be made across the prominent angle of the deformity and the patella is chiselled if adherent to the bone. If, however, the patella is free, the ligamentum patellae should be detached from its insertion into the tibia, the patella being turned upward with the flap.

EXCISION OF THE PATELLA

Murphy's Operation

Step 1. Enter the knee joint on the outer side of the patella through an incision about seven inches in length. (Fig. 8??[1].)

Step 2. Excise the patella subperiosteally. Leave the divided ends of the quadriceps femoris tendon as well as the tendon of the patella exposed. (Fig. 8??[1].)

Step 3. Fashion a flap consisting of portions of the quadriceps femoris tendon and vastus externus muscle.

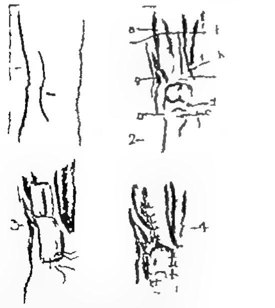


Fig. 8??. Excision of the patella (John B. Murphy). [illegible]

Step 4. Reflect the flap thus made downward (Fig. 8??[2].) The flap must be of sufficient length to reach the divided end of the patellar tendon without tension.

Step 5. Suture the end of the flap (e, f) to the ligamentum patellae (h, ?) either by an end-to-end suture or an overlapping one.

Step 6. Close the defect (e, f, g, h) with chromic catgut sutures. (Fig. 8??[ ].)

Step 7. Suture the aponeurosis of the patella firmly to the denuded edge of the flap (Fig. 8??[4]).

Step 8. Close the skin wound. Drain. Dress. Apply a posterior splint.

Comment. Before resorting to this operation the late John B. Murphy produced a chemical arthritis first. Murphy believed that the artificial arthritis created a local immunity to infection and so lessened accident in the operation. He used a mixture of formalin, 2 to 5 per cent in glycerin which is prepared 24 hours before being used. Of this solution two to six drachms are injected into the joint about two weeks before the operation.

EXCISION OF THE ANKLE JOINT

This excision may be indicated in cases of compound dislocation of the joint with comminuted fracture of one or more of the bones forming it, for tuberculous disease or severe suppurative conditions showing no tendency to heal, also in certain cases of talipes, etc.

The best operation for excision of the ankle joint appears to be that recommended by Kocher and Reverdin in which the joint is reached through a single incision situated on the anterior and lateral aspects of the foot.

Step 1. Make an incision across the dorsal and lateral aspects of the foot, commencing at a point one-half an inch below the center of the ankle joint and extending laterally and backward to the dorsal margin of the lateral malleolus and then proceed proximally and somewhat medially to the fibular margin of the tendo calcaneus. (Fig. 8??, a.) This incision, which is usually from 5 to 5½ inches long, is curved in outline, the convexity looking toward the tibial margin of the foot.

Step 2. Following incision of the superficial fascia, the lateral portion of the superficial peroneal nerve is sought for in the medial part of the wound and retracted to the medial side.

Step 3. When the deep fascia and the fibers of the transverse ligament of the leg have been cut through, the tendons of the extensor muscles will be exposed in the anterior part of the wound and those of the peroneal in the posterior part.

Step 4. The deep fascial processes of the cruciate ligaments and the peroneal tendons are separated and pushed backward; it may be necessary at times to cut through these tendons (Fig. 8??, b).

Step 5. Separate and retract toward the tibial side the extensor tendons at the anterior angle of the incision, the processes of the transverse ligament of the leg and the anterior ligament of the ankle joint.

Step 6. Separate also the other ligaments in the vicinity of the joint from their bony attachments and when this is accomplished the joint will be opened on its posterior, lateral and anterior aspects. The deltoid ligament is not disturbed.

Step 7. Forcibly adduct the foot toward the tibial side and completely dislocate it medially until the plantar surface lies in contact with the skin on the medial side of the leg (Fig. 8??, c).

Step 8. Saw off the diseased portions of the exposed bones; scrape away or dissect out all thickened and diseased synovial membrane and other soft

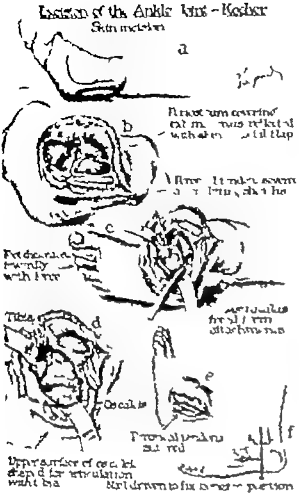


Fig. [illegible] Excision of the ankle joint (Kocher's method). In studying the illustration compare the legends with the text.

parts. It may in some cases be necessary to remove the talus entirely together with all infiltrated tissue. (Fig. [illegible], d.)

Step 9. When all affected tissues are disposed of, bring the foot into its original position. Reunite sectioned tendons with sutures. If possible suture the ligaments on the lateral aspect of the joint (Fig. [illegible]).

Step 10. Close the external wound without drainage.

Step [illegible]. Splint the limb until healing is complete and union of the divided tissues has taken place. (Fig. [illegible], f.)

EXCISION OF HEAD OF METATARSAL BONE OF THE GREAT TOE

This excision is frequently done in cases of hallux valgus. (See Hallux Valgus, p. [illegible].)

Step 1. Make an incision from [illegible] to [illegible] inches long over the antero-medial aspect of the metatarso-phalangeal joint in the direction of the long axis of the toe.

Step 2. Divide the soft tissues; open the joint.

Step 3. Separate the ligaments forming the capsule of the articulation from their attachments to the bone and the head of the bone is made to protrude.

Fig. [illegible] Excision of the metatarsal bone of the great toe.

Step 4. Remove the head of the bone with either saw or bone forceps in such way that the cut and trimmed off surface fits the base of the phalanx when the toe is forcibly straightened.

Step 5. Close the wound in the usual manner.

Excision of the Metatarsal Bone, Metatarso-phalangeal and Inter-phalangeal Joints

Excision of these joints is made in much the same way as the preceding and are illustrated in Figs. [illegible].

MEDIOTARSOTARSAL RESECTION

De Francesco's Operation

Resection of the foot may be indicated in tuberculosis of the bone when climatic, general and physical therapy prove unsuccessful. Localized bone infections can be evacuated in typical manner where indicated, completing the procedure with [illegible] plug. The latter procedure seems logical where the affected area is strictly localized. In [illegible] large series of cases of this type, bones near the affected area were apparently healthy. Small pieces of bone were obtained after proper preparation and guinea-pigs were inoculated with the material for the purpose of ascertaining the presence of tuberculosis.

Other amputations is performed in cases of tuberculosis involving the [illegible] and metatarsus. De Francesco considers amputation too mutilating [illegible] procedure and, in many cases, tried conservation of the foot by removing only the

affected part. Such [illegible] surgical concept [illegible] not new—[illegible] and Obalinski attempted it long ago. It may be noted in Gardner's book on Operative Methods, that Obalinski excised the foot between the 3rd and 4th toe [illegible] between the cuboid, the cuneiform and the scaphoid bones to the posterior tarsus, astragalus and calcaneus. The tendons of the toes and peroneus longus are of [illegible] importance in operating for the equilibrium of the foot. [illegible] between the 2nd and 3rd toes, then between the 2nd and 3rd cuneiform so as to be nearer to the [illegible] of the external side of the foot. Such procedure enables the surgeon to close [illegible] the diseased bones and [illegible] and [illegible] having [illegible] foot without toes, nevertheless leaves the patient [illegible] for walking with the aid of [illegible] proper prosthesis. It must be remembered

Fig. [illegible] Excision of the metatarso-phalangeal and interphalangeal joints. A, [illegible] incision; B, [illegible]

that Oller noted that such resections may result in deformation of the foot when bony parts are left on one side. Another objection to the Obalinski method is that the plantar [illegible] may at times be painful in walking.

Let us consider the methods of anterior incision of the foot as in classical amputations. Delbet, [illegible] and Koval speak of [illegible], disarticulation of the foot in tuberculosis. The anterior approach offers the advantages of great visibility and perfect access to the articular structures concerned. [illegible], in [illegible] monograph on tuberculosis of the foot also prefers the anterior approach. The incision consists of [illegible] dorsal incision as if [illegible] Chopart amputation were contemplated, section of the tendons and of the small branches of the [illegible] nerve. The tendons of the tibialis anticus and peroneus [illegible] are not [illegible]. After opening the posterior articulation (Chopart) and outlining the parts to be removed, the osseous structures are opened in such [illegible] way that crosses

of the bone gave rise to [illegible] curved foot instead of leaving a flatfoot. The cut tendons were then sutured. As [illegible] rule the results were unsatisfactory.

The lateral approach [illegible] obviously preferable to the anterior or Obalinski method. The diseased bones are removed without injuring the tendons, vessels and nerves. For this reason, on the [illegible] [illegible] and clinical examination, the area to be removed is decided accurately [illegible] (Figs. [illegible]). When the [illegible] affects not only the [illegible] but also the bases of the metatarsus, resection seems preferable to amputation.

Step [illegible]. The external incision is of utmost importance because often through this alone [illegible] it is possible to complete the operation. De Francesco also used an external incision in his first operations, extending [illegible] slightly beyond the limits of resection, starting at the external malleolus or [illegible] in front of [illegible] and extending [illegible] to the head of the first metatarsus (Fig. [illegible]).

Step [illegible]. After having exposed the metatarsus the most important part of the procedure consists in the separation of the tendons and vessels from the bone (Fig. [illegible]).

Step 3. Following that attention is given to the tendons of the tibialis anticus and peroneus (external cuneiform, scaphoid) and to the tendon of the peroneus longus at the inner side of the first metatarsus. The tendons are separated with their insertions [illegible] by means of mallet and chisel. Fig. [illegible]. All soft parts are separated close to the bone so that only the tarsal area [illegible] the ligaments remains. This dissection is extended to the external margin of the foot.

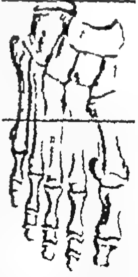


Fig. [illegible] Mediotarsometatarsal resection. [illegible]

De Francesco used in his first cases an external incision and through this wide lateral opening he found easy to pass the blade of [illegible] saw that was inserted from the other side cutting the bones in [illegible] manner similar to that used in the anterior method. In [illegible] succeeding cases he preferred to work with chisel using [illegible]

the axis of the foot and progressing with it until it was felt below the skin of the opposite side, beginning the division of bone distally then on the

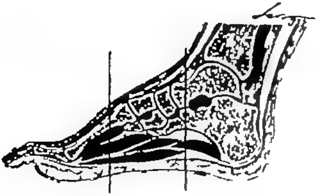


Fig. 842. Mediotarsal resection. (Courtesy Prof. Dante de Francesco.)

proximal side with the result that the curved surfaces were parallel to one another (Fig. 843).

Fig. 843. Mediotarsal resection. (Courtesy Prof. Dante de Francesco.)

Step 4. The resected segment of bone is grasped with Farabeuf bone forceps and slowly liberated (Fig. 844).

Step 5. A large cavity remains. Ligate bleeding vessels, explore the soft tissues and remove suspicious portions down to healthy bone.

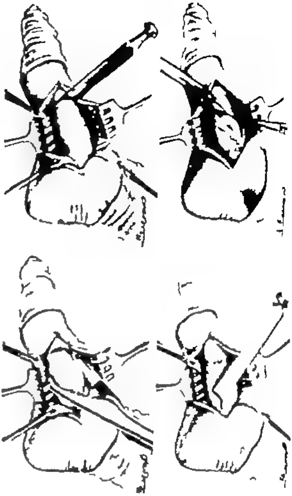


Fig. 844. Mediotarsal resection. (Courtesy Prof. Dante de Francesco.)

Step 6. The curvilinear parallel sections permit of perfect union of the bone ends without any angulation. If the bone section is effected with straight chisel the planes must be parallel to each other and perpendicular to the long axis of the foot.

The bone surfaces are fixed in position by means of metallic suture or with temporary splint and in some instances with inlaid bone grafts of healthy bone (Fig. 845).

Fig. 845. Mediotarsal resection. (Courtesy Prof. Dante de Francesco.)

Step 7. A well molded plaster of Paris cast supports the arch. Later metallic arch support is useful to prevent flatfoot.

Patients treated in the manner described were able to walk with shortened but useful foot.

EXCISION OF THE TEMPOROMANDIBULAR JOINT

(See Surgery of the Head.—Chapter 14, page [illegible])

Excision of this joint must be carried out with particular care owing to the important anatomical structures which are in close association with it. These are, principally, the auriculotemporal nerve and the superficial temporal artery which lie posterior and external to the joint, the internal maxillary artery below and internal, the glenoid lobe of the parotid gland immediately behind the condyle and the facial nerve lying in the parotid gland at lower level.

An incision about 1½ inches in length, is made along the inferior margin of the posterior part of the zygomatic arch, commencing immediately in front of the anterior margin of the external auditory meatus and extending forward toward the prominence of the zygomatic bone. In dividing the overlying tissues, the nerves and blood vessels are carefully avoided. The fibers of the masseter muscle are retracted forward and the parotid gland backward. The external

portion of the capsule of the joint is divided and the cavity opened. The neck of the lower jaw is next freed and is divided with fine saw from in front backward. The condyle is then seized with pair of heavy forceps and forcibly pulled outward. The undivided parts of the capsule are cut through with the scalpel and the external pterygoid muscle is detached from the anterior and internal aspect of the neck of the mandible immediately below the articular surface. The head of

Fig. 846. Open method of arthrotomy of the shoulder joint.

the bone can then be removed, the interior of the joint examined and diseased tissue or tumor removed. The condyle is usually the only portion that is removed.

ARTHROTOMY

This surgical procedure is usually resorted to for evacuating an articular effusion. The surgeon may actually open into the joint cavity by means of short incision (open arthrotomy) or enter the joint space with trocar through puncture wound (closed arthrotomy). The approach selected may be from an anterior or posterior aspect depending upon the joint to be entered.

Arthrotomy of the Shoulder

ANTERIOR APPROACH

Step 1. Abduct the arm slightly and identify the coracoid process. One inch lateralward to this point, begin an incision which proceeds downward in the direction of the fibers of the deltoid muscle for a distance of about three inches. Locate the anterior border of the deltoid and divide its fibers avoiding the cephalic vein and branch of the acromiothoracic artery.

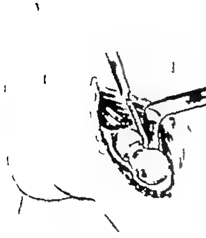


FIG. [illegible]. [illegible] method of arthrotomy

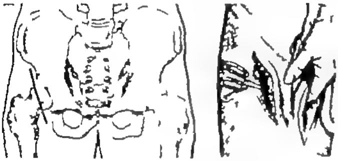


FIG. [illegible] FIG. [illegible]
FIG. [illegible]. Anterior arthrotomy of the h[ip]. Note direction and position of [illegible]. (After [illegible])
FIG. [illegible]. Arthrotomy of the hip joint. (After Lilley)

which is then split and spread, exposing the joint capsule (Fig. [illegible]). If the cavity is expected to yield purulent material or the likelihood of infection is great, through-and-through drainage is advisable (Fig. [illegible]). A drain is passed from within outward through [a] lateral incision identical with the one on the medial aspect of the knee (Fig. [illegible]).

FIG. [illegible]. Arthrotomy of the hip joint. Always make sure that the femoral vessels are protected. During the operation keep the index finger of the left hand constantly upon them. This procedure will tend to safeguard the vessels from injury. [illegible] [illegible] directions. The illustration shows how not to proceed by having femoral vessels unprotected.

Step 2. Open the joint capsule. Irrigate thoroughly. Close the capsule except where frank pus is encountered.

Step 3. Divide down to the capsule in those cases where satisfactory joint closure has been effected. Drain simply and allow early motion. In case of ankylosis the position of optimum function depends upon the patient's occupation as previously described.

CLOSED METHOD

Step 1. Extend the leg and palpate the patella.

Step 2. Insert the needle obliquely between the patella and femur anywhere along the medial or lateral border of the patella. Entrance may be facilitated by pushing the patella to one side or the other thus opening the joint and swelling the capsule on the side being entered (Fig. [illegible]).

Arthrotomy of the Ankle

OPEN METHOD

Step 1. A two-inch vertical incision is made along the anterior border of the external malleolus. The anterior ligament is divided and the joint opened just in front of the malleolus (Fig. [illegible]).

Step 2. A closed forceps is passed through the above incision across the ankle to the inner side of the limb, passing through the joint and behind the synovial sheath of the extensor tendons (Fig. [illegible]). The soft parts anteriorly in front of the internal malleolus are incised with the point of the forceps and are then incised. Drainage is thus established.

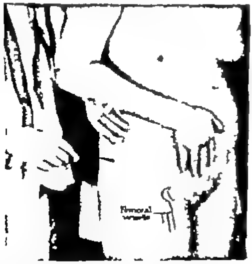


FIG. [illegible]. The hip joint may also be reached by introducing the aspirating needle from [illegible], as shown in the illustration. The needle [is] permitted to glide along the upper border of the trochanter until [it] reaches the joint.

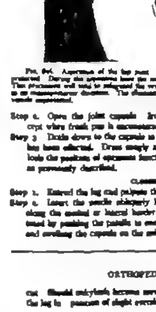
Step 3. If the anterior approach is deemed insufficient [a] posterior opening can be made behind the external malleolus on the outer side of the tendo Achillis. Closed forceps are passed through this opening through the posterior part of the joint until the point projects against the tissues behind the internal malleolus where the forceps is cut down upon, care being taken to safeguard the posterior tibial vessels and nerves as well as the flexor tendons of the foot.

4. Establish drainage (Fig. [illegible]). Leave the wounds open and drain. Permit, even enforce, early motion especially if [a] purulent exudate is present.

out. Should ankylosis become inevitable, place the foot at right angles with the leg in [a] position of slight eversion.

CLOSED METHOD

Step 1. Select an anterior or posterior approach depending upon the point of maximum swelling and tenderness. If the former, [the] selected entrance [is] made between the external malleolus and the lateral border of the extensor digitorum longus. The posterior approach is between the tendo-Achillis and the tendons of the peroneal muscles.



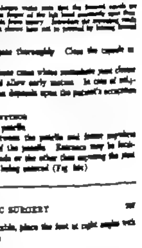


FIG. [illegible] FIG. [illegible]
FIG. [illegible]. Arthrotomy of the knee joint. (After Lilley)
Arthrotomy of the knee joint. Note position and [illegible] of [illegible]. (After Lilley)

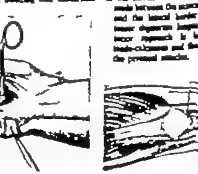


FIG. [illegible]. Method of draining the knee joint. (After Lilley)

Step [illegible]. After selecting the site of entrance, direct the needle inward and downward seeking to enter the space between the tibia and talus (Fig. [illegible]).

Loose Joint Bodies ("Joint Mice")

The function of [a] joint is not infrequently impaired by the presence of loose body within the joint space. The knee joint [is] most often involved. The

Fig. [illegible] Exposure of the knee joint. [illegible]

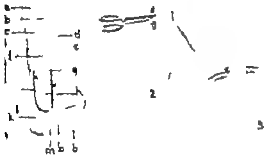


Fig. [illegible] Arthrotomy of the ankle joint. [illegible]

[illegible] most frequently associated with this condition are osteo-arthritic changes, displaced epiphyses or detached portions of articular surfaces.

Osteo-arthritic changes give rise to several forms of loose bodies. One is the chondroma which is an oval pellet composed of cartilage cells. They occur singly

Fig. [illegible] Arthrotomy of the ankle joint.

or in great numbers. Another form of joint bodies results from hyperplasia of [illegible].

Epiphyseal displacement occurs most frequently in the elbow joint due to the medial epicondyle being traumatically displaced into the joint cavity. [illegible]

Fig. [illegible]

of motion and not pain [illegible] the major symptom although the area over the epicondyle [illegible] very tender. (Fig. [illegible])

The [illegible] cartilage of the knee often becomes torn or detached following [illegible] or forced rotation of the foot and leg. The knee locks in slight flexion and the pain is great.

Treatment consists of opening the joint cavity and removing the offending body. [illegible]

[illegible] the knee joint [illegible] most frequently opened, the approach will be given. [illegible] anterior and posterior compartments.

Fig. [illegible]

EXPOSURE OF THE ANTERIOR COMPARTMENT

Step 1. A four-inch incision is made between the vastus medialis and rectus femoris [illegible] to the patella. (Fig. [illegible])

Step 2. [illegible] until the joint capsule [illegible] exposed. [illegible] widely. (Fig. [illegible])

Step 3. Flex the leg [illegible] retract the patella [illegible] and the anterior compartment [illegible] exposed. (Fig. [illegible]) [illegible] carefully and remove all loose bodies.

Step [illegible]. Effect complete closure. (Fig. [illegible]) Dress the wound.

EXPOSURE OF THE POSTERIOR COMPARTMENT

Step 1. Extend the knee. Make [illegible] four-inch incision along the [illegible] border of the biceps [illegible] muscle and over the joint space.

Step 2. Flex the knee. Forcibly retract the biceps laterally. Identify the [illegible] and divide.

Step 3. [illegible] dissect downward to the joint capsule. Incise it widely thus exposing the posterior compartment.

Step 4. Close and dress the wound.

ARTHROPLASTY—THE MOBILIZATION OF ANKYLOSED JOINTS

Until recent years, surgeons have believed that ankylosis in good position [illegible] the best curative result to be sought in certain traumatic or infectious joint lesions. With the development of surgical technic and particularly with the advancement of the specialties, surgeons, alert to the great disability caused by an ankylosed limb, have endeavored to restore motion to the joint by the use of many different operative procedures. The surgical methods devised and practiced have shown [illegible] advance in keeping with the broader understanding of the pathology of ankylosed joints, until finally the method termed arthroplasty was evolved.

An arthroplasty is [illegible] highly technical operative procedure which aims not only to restore motion to [illegible] joint, but also to preserve stability. With these two objects in view, the component parts of the joint are reconstructed, and material of some kind [illegible] interposed between the articular ends to prevent re-ankylosis.

Arthroplasty has become [illegible] standardized form of treatment for the mobilization of ankylosed joints.

In general terms, an arthroplasty is the creation of an artificial joint for the purpose of restoring motion to [illegible] joint which is either completely ankylosed, or which has such [illegible] limited degree of motion that the limb is not serviceable.

Modern Arthroplastic Methods

The development of the [illegible] flap method in modern arthroplasty methods is due to the late John B. Murphy of Chicago, who was more persevering than any other surgeon in his endeavor to restore motion to ankylosed joints. The method devised by Murphy has formed the basis of the great majority of modern arthroplastic measures.

The essential feature of the Murphy operation is the insertion of [illegible] pedicled flap of fascia and fatty tissue taken from the vicinity of the operated joint. Murphy believed that the transplant received its nourishment through the pedicle. He also placed [illegible] great deal of emphasis upon the inclusion of [illegible] considerable quantity of fatty tissue for he believed that the fat aided in laying the foundation of the new joint by forming [illegible]. The technic of the Murphy operation varied as necessitated by the anatomic structure of each joint. Murphy was most successful in treating ankylosis of the [illegible].

The fundamental changes that have taken place in the technic of arthroplasty since the Murphy method was perfected are the omission of the pedicle of the flap and the use of fine fascia lata without the inclusion of fatty tissue. Careful study and experimentation have led to this development. [illegible]

[illegible] proved that the flap did not receive nourishment through [illegible]. It was demonstrated both experimentally and [illegible]

Remove the cast at the end of four weeks and allow the patient to walk with crutches. At night he is placed in a cast and also twice a day for one hour periods to avoid malposition and contracture of the soft parts. The cast may be used for several months to fix the pelvis and prevent compensatory movement in the hip joint. Passive motion is carried out at regular intervals.

Determine the increase in weight-bearing by the density of the head and neck disclosed by the roentgenogram. Osteoporosis or bone atrophy may follow any operative procedure on a joint and so decrease the resistance of the cancellous bone that compression and disintegration may occur from pressure induced by the weight of the body. These complications may be best avoided by the adjustment of weight bearing through apparatus which places the weight of the body on the perineum and tuberosity of the ischium gradually permitting weight to be borne on the foot as the tensile strength of the bone increases.

Arthroplasty of the Elbow

Indications

1. Ankylosis following trauma
2. Ankylosis resulting from acute pyogenic infection
3. Tuberculosis

Step 1. Make an incision on the posterior surface of the arm and forearm just external to the midline; the incision starts above at the center of the humerus, extending downward to about 3 inches below the elbow joint and divides the skin, superficial and deep fasciae without separation. Dissect the deep fascia laterally about an inch. In cases of ankylosis in extension, cut the broad aponeurosis of the triceps transversely at the upper end of the forearm, and divide it at its inner and outer borders.

Step 2. Form a long flap of thick fascia, attached to the tip of the olecranon process.

Step 3. Make a further incision in the midline passing through the triceps muscle and periosteum over the lower half of the humerus. Strip the periosteum from the lower third of the humerus. This exposes the head of the radius and olecranon process (Fig. 874 A).

Step 4. Cut the fusion between the olecranon process, radius and humerus with curved chisel. Flex the joint and dislocate it to the medial aspect.

Step 5. Fashion the lower end of the humerus into one condyle convex from before backward (Fig. 874 B). Do not attempt to reproduce the anatomic contour of the capitellum and trochlea.

Step 6. Excise the superficial bone from the sigmoid cavity and denude the head of the radius to the level of the inferior portion of the sigmoid cavity.

Step 7. Smooth all surfaces with a rasp.

Step 8. Transplant and suture a large piece of fascia lata from the lateral surface of the thigh over the lower end of the humerus, and reflect it over the sigmoid cavity. When the ulna and radius are united, remove enough bone to allow free movement of the radius (Fig. 874 C). The two bones are then separated by a fold of the fascia, and the head of the radius is covered with it.

Step 9. Reduce the articulation and close the joint capsule from below upward with the elbow flexed at 90 degrees. The tongue of the triceps aponeurosis, when cut, is sutured at a point below its former position, to allow free play of the joint when it is in flexion.

Step 10. Close the deep fascia and skin.

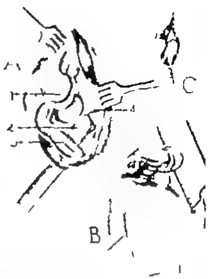


FIG. 874. Arthroplasty of the elbow joint (Kocher). A. The joint has been opened, subperiosteally freed, ligamentous attachments and periosteum, articular end and upper end of ulna are also denuded from upper surface of capsule and synovial membrane. B. Shaping of ends of radius, ulna and end of humerus. C. The joint, showing following approximation of fashioned ends of bone. Tendon and muscle sutured. Transplanted fascia covering ends of bone not shown.

In cases of ankylosis with the elbow flexed, the triceps, instead of being cut transversely, is severed longitudinally along the outer border and retracted inward.

Immobilize the arm in a splint at a ninety-degree angle or cast for about weeks. After complete healing, remove the cast every day and begin gradual passive and active motion.

WILLIS C. CAMPBELL TECHNIC OF ARTHROPLASTY OF THE ELBOW

Step 1. Make an incision six or eight inches long on the posterior aspect of the arm and forearm, just external to the midline (Fig. 875) beginning above, about the middle of the humerus and extending to about two or three inches below the elbow joint.

Step 2. Expose the broad aponeurosis of the triceps by dividing the skin, superficial and deep fascia without separation. Dissect the deep fascia laterally about one inch. Dissect the broad aponeurosis from above downward making a long tongue attached to the tip of the olecranon process below (Fig. 876 A).

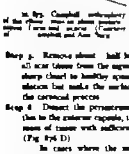


FIG. 875. Campbell arthroplasty of the elbow. Line of skin incision posterior aspect. (Courtesy of W. C. Campbell and Ann. Surg.)

Step 3. Make a further incision in the midline penetrating the muscular fibers of the triceps and periosteum to the humerus over the lower half. Use a periosteal elevator to strip the periosteum from the lower third of the humerus. Remove all scar tissue, callus and loose bone particles. Reduce any dislocation, if present, with periosteal elevator, strap or any blunt instrument (Fig. 876 B).

Step 4. Avoid nerve and vessel injury by staying close to the bone. If the ulnar nerve is exposed, isolate and anchor it safely. Remove about one-half to one inch from the lower extremity of the humerus and convert it into a surface convex from before backward; do not try to reproduce the trochlea or capitellum (Fig. 876 C).

Step 5. Remove about a half inch of bone from the olecranon process. Dissect all scar tissue from the sigmoid cavity. Remove the affected surface with sharp chisel to healthy spongy bone. Do not disturb the radio-ulnar articulation but make the surface of the head of the radius the same level as the coronoid process.

Step 6. Dissect the periosteum and triceps muscle into a double flap; attach this to the anterior capsule, thus separating the new bony surfaces by a living mass of tissue with sufficient blood supply and free from pressure necrosis (Fig. 876 D).

In cases where the radiohumeral articulation is normal with bony ankylosis between ulna and humerus, the radiohumeral joint is not destroyed but a bone-arthroplasty is done between the humerus and ulna. In these cases it is sometimes impossible to obtain sufficient posterior flap in lieu of which the aponeurotic broad tongue from the triceps is placed between the surfaces. Use this structure also when the posterior flap cannot be secured.

Step 7. Suture the capsule of the joint to the posterior aspect of the triceps

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muscle and deep fascia, closing off the new joint. Close the wound in layers with catgut and dermal for the skin.

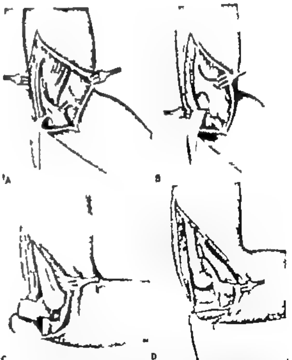


FIG. 876. Campbell arthroplasty of the elbow. A. Tongue of the broad aponeurosis of the triceps dissected out. B. Dislocation reduced. C. End of humerus removed and made convex from before backward, periosteum and triceps muscle sutured over double flap covering new bony surfaces. (Courtesy of W. C. Campbell and Ann. Surg.)

Arthroplasty of the Wrist

OLLIER'S OPERATION

Step 1. Make a longitudinal incision along the radial side of the extensor tendons of the index finger exposing the wrist joint. Continue the incision upward exposing the lower part of the extensor communis digitorum. Ex-

Excise a segment of free fat from either the abdomen or the buttocks, of sufficient size to fill the bone cavity.

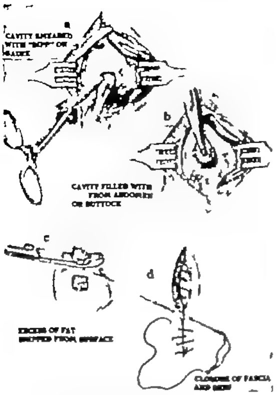


Fig. [illegible] Continuation of operation shown in Figure [illegible].

Step 7. Apply Bipp paste to the fat transplant and introduce it into the bone cavity. Any protruding parts of the fat transplant above the bone surface should be trimmed away (Fig. [illegible] b, c).
Step 8. Close the skin with silk or silkworm-gut sutures (Fig. [illegible] d).
Step 9. Apply gauze dressings saturated with alcohol protected by voluminous gauze or cotton dressings. Avoid pressure over the wound.

Step 10. Immobilize the limb with either splints or cast.
Step 11. Change the dressings the day following the operation. Redress the wound for two or three weeks with B I P P paste.

The above method may also be used in all cases of chronic osteomyelitis. The presence of suppuration is no contra-indication for the operation. If [illegible] exists, the extent of bone involvement may be ascertained by injecting bismuth paste into the sinus. Where no sequestrum is present the bismuth paste may clear up some cases.

CHRONIC OSTEOMYELITIS

In the days gone by surgeons waited for an involucrum to form. Modern trends point toward removal of the dying or dead bone (sequestrectomy) after reasonable delay; this may be done in the subacute stage or when the disease has become chronic.

Sequestrectomy

Step 1. Make a longitudinal incision over the soft tissues down to the bone. Usually fistulae are present. Excise them. Retract the soft tissues thoroughly.
Step 2. Expose the abscess cavity thoroughly and evacuate its contents painstakingly. If the sequestrum is found superficial remove it with sequestrectomy forceps (Fig. [illegible]). If it (the sequestrum) is situated in the involucrum remove with a chisel only enough of the latter to permit the extraction of the former. Do not molest the newly formed bone more than is absolutely necessary.
Step 3. Remove all pathologic tissues (granulation tissue), debris, necrotic bone, etc.) with gentle bridging [illegible] projections with a curet (Fig. [illegible]). If in doubt that all infected tissue has been removed, pack with vaselined iodoform gauze for a few days. Close later with sutures. If it is believed that no infectious material has been left behind, the wound may be closed. Some [illegible] filling the remaining cavity with a powder consisting of iodoform one part and crystals of boric acid, four parts.
Step 4. Dress. Fix the limb in a splint.

The Winnett-Orr Treatment of Osteomyelitis

The Orr Method of treating osteomyelitis is a "method of management" of acute and chronic pyogenic infections of bone whether primary or secondary to such conditions as compound fractures. The method includes not only the technic of the operation itself, but the postoperative management as well. The entire plan of campaign rests upon several general fundamental principles of treatment.

The underlying principles of the Orr Method are, in essence, that infections of bone call for adequate drainage and prolonged rest. Drainage must not only occur at the time of operation, but must continue throughout the period of healing. The term "adequate drainage" is a sine qua non. Rest must be complete and constant. This applies to the infected part and the healing wound: the latter must remain undisturbed. If the surgeon fulfills these requirements, the natural resources of the patient can be counted upon to overcome the infection and effect healing.

OUTLINE OF THE ORR TREATMENT

Step 1. Immobilize the patient at once on the operating table in the best possible position, anatomically.
Step [illegible]. Do a thorough drainage operation, preceded by débridement if necessary.
Step 3. Pack the entire wound with vaseline gauze so that it is wide open from bottom to surface.
Step 4. Apply an extensive, well-fitting plaster of Paris cast.
Step 5. Do not disturb the cast, the dressings, the wound, or the injured part except in the face of definite complications.

DETAILS OF THE ORR TREATMENT

Step 1. Preliminary. Before any surgical procedure is begun, the patient is immobilized on a fracture table with all of the injured or affected parts in as nearly correct anatomic position as possible. This may require manipulation in the case of contractures or the use of skeletal traction in the presence of fractures. The patient is placed in the best possible position in order that the operation may be carried through and plaster-of-Paris applied without further motion of the injured or inflamed parts and so that the position desired, once obtained, will not be disturbed in any way during the postoperative course.
Step 2. Operation. Make an incision that will thoroughly uncover the infected area. Retract the skin, muscles, fascias and periosteum far enough to expose thoroughly the diseased bone in its entire extent. Remove foreign materials and dead or dying tissue; chisel out necrotic bone; remove sequestra and convert the wound into a saucer-shaped cavity ("saucerization"). Do not remove bony or soft parts that may contribute to repair. The operation is not to be unnecessarily prolonged or traumatizing, but is to provide an open cavity without over-hanging edges from which free drainage will be possible. Wipe out the wound with tincture of iodine followed by alcohol, and dry with sterile gauze.
Step 3. Closure. Fill the cavity with a sterile vaseline gauze pack from the depths to the surface of the wound. Pack gently, firmly but not tightly. When the packing is flush with the surface, add flat strips of vaseline gauze so that this flat dressing extends somewhat beyond the margins of the wound. Cover with a dry sterile, absorbent pad to take up drainage at the edges of the vaseline dressing. Use no drainage tubes or other foreign materials in the wound. *Do not suture or otherwise cover the infected area with flaps of muscle, fascia, or skin.*
Step 4. Splinting. The desired position having been previously established, the affected part is now immobilized so as to preclude muscle spasm and to avoid contractures. A well-fitting and extensive plaster of Paris cast is the most efficient device to use. Into the plaster may be incorporated, in the case of fractures, pins, nails, or traction straps used to control the fracture fragments. The splinting device, usually plaster of Paris, is to be extensive enough to control the affected part and the patient.

5. Dressings. Dressings in the usual sense of the word are not done. The plaster of Paris cast is applied so as not to be fenestrated or split, and

so as to prevent tampering with the wound. The postoperative course of the patient is to be taken as an index of the condition of the wound. If immobilizing devices become inefficient or if odor, because of wound infection, becomes objectionable, dressings may be changed in the operating room and under anesthesia (usually) without disturbing the anatomical relationships of the affected part and with minimal disturbance of the healing surface. In most instances the original dressing and cast may be left undisturbed for from four to eight weeks, or even longer, by which time the wound is protected by healthy tissue. But even these secondary dressings should be as carefully and as infrequently done as possible.

OPERATION FOR OBLITERATION OF BONE CAVITIES

This is often difficult to accomplish. The sequestrum and all diseased tissue must, of course, be completely but gently, removed. Failure is to be expected if free drainage is not obtained. Sinuses must be excised.

Schede's Aseptic Blood Clot

The method finds its greatest application in bone cavities not resulting from septic osteomyelitis. The gauze pack is removed from the cavity in the bone. The soft parts are sutured with buried catgut sutures. The skin is closed. Provide drainage (Penrose tube, strands of silkworm-gut). Dress. Immobilize the limb. Remove the tourniquet. Enough bleeding will ensue to fill the cavity. The excess is drained off via the drainage. After a day or two release the limb from the [illegible] elevated position. When no infection ensues, the cavity will heal in about a month or two. *If infection supervenes evacuate the clot and institute free drainage.*

Senn's method consists of using decalcified bone chips to fill the cavity.
Mosher's method substitutes iodoform-starch as filling material.
Mosetig-Moorhof, an iodoform wax plug.

BONE PLASTICS

Beveling Off the Edges of the Cavity

Here an endeavor is made to cause the soft tissues to project and adhere to the walls of the cavity producing a depression lined by skin. Figure [illegible] depicts the method.

COMPOSITE PEDUNCULATED FLAP

Von Eiselsberg Operation

This operation is particularly adaptable to large defects in the tibia.

Step 1. Apply a tourniquet. Plan a pedicled flap so that it may be easily swung into the osteoplastic and vascular defect (Fig. [illegible]). Do not detach the skin from over the bone any further than is sufficient to enable a chisel to cut through the cortical plate of the tibia corresponding with the planned flap. In other words, a composite skin periosteo-osteal flap should result. The flap is rotated into position into the defect in the tibia, avoiding too much torsion of the pedicle. Suture the flap into position.
Step 2. Undermine the flap at the upper wound and bring the edges together

by interrupted sutures. Avoid pressure when applying the dressings. Secondary skin grafts to fill defects are often needed. Remove the tourniquet. Dress. Immobilize in a splint.

Comment. In treating an established osteomyelitis (Fig. 864) one should not use a sharp spoon or curet to remove the suppurating medulla, as it is likely also to remove osteogenetic portions of the medulla which have escaped suppuration. No bone should be removed except what is actu-

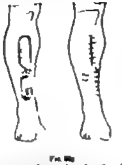


FIG. 862. FIG. 863.

FIG. 862. [illegible]

FIG. 863. [illegible]

ally necessary for the purpose of ample drainage; on the other hand removal of all devitalized tissue must be complete, otherwise sinuses may result.

Definitely necrotic bone should be removed before it degenerates into true sequestrum; that is, before the dead portion has become locked in and buried by newly formed periosteal bone (involucrum). The best time to remove necrotic bone is while the periosteum is still soft and pliable.

Rib Resection in Osteomyelitis of the Rib Ends

CHURCHILL TECHNIQUE

Step 1. Make a longitudinal incision through the periosteum overlying the affected rib. Reflect the affected anterior periosteal layer with a periosteal elevator (Fig. 865).

Step 2. Free the posterior layer by means of a Doyen raspatory and remove a section of the rib with a costotome (Fig. 866). As a result of the simple longitudinal incision, V-shaped areas of the ends of the ribs have been left devoid of periosteum, and, if left exposed in an infected chest wound, it is easy

to see that sequestration may take place followed by separation of the devitalized fragments and their retention in the empyema cavity.

Step 3. To avoid the above, Churchill separates the periosteum from the rib in the manner shown in Fig. 867. Make a transverse incision at each end of the longitudinal one, permitting the periosteum to be elevated in the form of two flaps. This affords clean reflection of the periosteum and gives a line for the section of the rib by the costotome leaving the cut ends of the rib squarely covered by periosteum.

To cover the ends of the rib by suturing flaps of periosteum over them is, according to Churchill, "not only time consuming but by the introduction of suture material may actually invite infection. Churchill believes the simple technic is adequate, and that it will facilitate the operation as well as prevent the formation of chronic sinuses after the drainage of empyemas (Fig. 868).

FIG. 864. X-ray of extensive osteomyelitis of the humerus.

SUBPERIOSTEAL EXCISION OF SCAPULA AND CLAVICLE

Scapula—Ollier's Operation

The operation is performed in cases of osteomyelitis and its sequelae.

Step 1. Make an incision penetrating the tissues to the bone along the spine of the scapula from the acromion to the vertebral margin. By means of sharp and blunt dissection, divide the trapezius from the scapular spine (Fig. 869).

Step 2. Incise and expose the entire vertebral border of the scapula. Divide the soft parts from the bone both above and below the scapular spine, subperiosteally through this incision.

Step 3. Retract the vertebral border of the scapula from the chest and divide the subscapularis and other tissues subperiosteally from the inner surface of the scapula to the axillary border and neck of the bone.

Step 4. Separate the acromioclavicular joint from below upward; incise the tendons and articular capsule on the upper end of the humerus; incise the base of the coracoid process. Unless removal of the scapular head is deemed essential, it is better to leave the articulating surface of the bone intact and divide only the neck.

FIG. 865. [illegible]

FIG. 866. [illegible]

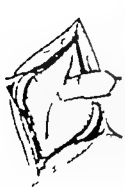


FIG. 867. [illegible]

FIG. 868. [illegible]

This operation is much more easily performed upon a patient in whom it is indicated than on a cadaver because disease renders the periosteum thicker and causes it to become detached from the bone.

Subperiosteal Resection of the Clavicle

This operation is indicated in cases of necrosis of the clavicle.

Step 1. Make an incision along the clavicle from the acromion process to the sternum including the periosteum (Fig. 870).

Step 2. Divide the periosteum from the anterior surface of the bone with a periosteal elevator.

Step 3. Detach the periosteum from the posterior surface of the bone, near the middle, with a curved elevator.

FIG. 869. Resection of scapula (Ollier method).

Step 4. (a) Divide the bone near the center with a Gigli saw or bone forceps. With a strong forceps, grasp the end of the inner fragment, pulling it forward. Removal of the fragment is easily accomplished by blunt dissection and the occasional use of the scissors which should always be made to cut against the bone. It is preferable to leave the articular end of the bone in

FIG. 870. Subperiosteal excision of clavicle [illegible]

place and divide the bone near its sternal articulation. Repeat at the external end of the bone. Sharp dissection is necessary where the subclavius [illegible] the outer and middle thirds of the bone. A knife is used to divide the [illegible] and coracoclavicular ligaments if the external end of the bone is to be freed, but the acromioclavicular joint should always be preserved, if p

(b) Excise the clavicle close to its external end or upon the scapulo-clavicular joint instead of the middle. Pull the outer end of the bone forward. Detach the soft parts from the clavicle subperiosteally and remove it partially or completely.

Step 3. Clean out the wound and close it. Institute free drainage where it is required.

Adjuvant Nonsurgical Treatment of Osteomyelitis

BAER'S MAGGOT TREATMENT

This form of treatment has been reported upon favorably as useful adjunct in the surgical treatment of chronic osteomyelitis. In [illegible]

Fig. [illegible] Fig. [illegible]

[illegible]

small hospitals, however, the breeding and care of sterile maggots is impractical and their purchase rather expensive. Moreover, the permanency of the results obtained by this method cannot yet be reported upon unequivocally.

[illegible] TREATMENT

[illegible]

thick on the affected area extending well over the healthy skin margin and is covered with a waterproof dressing, since the paste must be kept moist. [illegible]

In prolonged drainage in an osteomyelitic area there is danger of erosion of the vessels by the drain.

In an extensive removal of necrotic bone in osteomyelitis, the possibility of fracture should be remembered and guarded against.

In extensive osteomyelitic processes involving the femur or humerus, the risks of shortening and deformity are great (Fig. [illegible]).

In obscure fevers, particularly in children, always think of the possibility of acute osteomyelitis. Treat it promptly; surgically.

[illegible] METHOD

[illegible]

TUBERCULOSIS OF THE BONES AND JOINTS

Richard B. Dillehunt [illegible]

[illegible]

[illegible]

In the early case, prompt removal of superimposed weight and the prevention of deformity are mandatory. [illegible]

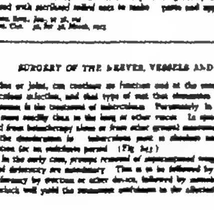


Fig. [illegible]

[illegible]

[illegible]

Pott's Disease

Tuberculosis of the Spine, Caries of the Spine, Angular Curvature of the Spine

Tuberculosis of the spine was first studied by Percival Pott and bears his name. [illegible]

[illegible]

abscess. In the cervical region pus may collect in the retropharyngeal area or as deep cervical abscess. The involvement of the upper dorsal region may point in the posterior mediastinum. The most frequent site of abscess formation is in the lower dorsal and lumbar regions; here the course is downward along the psoas muscle pointing in the groin, flank or over the buttock. An intrapleural

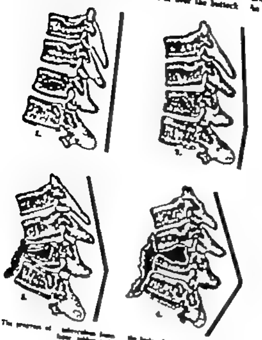


Fig. The progress of tuberculous bone, the body of vertebra with tendency of [illegible] and abscess formation.

abscess, probably the most frequent cause of the paralysis seen in these cases. Bone compression of the cord [illegible]. The "abscess paraplegia" (usually latent) most frequently manifests itself about two years after the onset of the disease and even though established for a considerable time [illegible] amenable to treatment by prolonged fixation.

Actual symptoms of spinal caries may be preceded by a period of lassitude, malaise, poor appetite or loss of weight. The first indication of spinal disease is often pain. In the infant all movements cause acute distress and pain, fre-

quently worse at night. Older children voluntarily assume a rigid attitude made more acute by involuntary spasm (Figs. 805, 806-807). The patient is reticent to stand and muscular weakness may be marked. Deep palpation elicits pain over the affected area or an early deformity can be detected. The adult patient tends to have fewer premonitory symptoms and the onset of pain is often acute. Special attention should be given to the loss of body height, peculiarities in attitude or gait and finally gross deformities as gibbus, abscess formation or paralysis. A primary focus may be determined by a systematic investigation.

Treatment has for its object the cure of the disease and to correct or prevent further deformity. The first employs the usual antituberculosis measures and the latter employs local treatment. Local treatment of uncomplicated cases [illegible] the majority of the cases of Pott's disease is first, complete and fixed recumbency followed by a careful and gradual return to activity. Forms of fixation generally used are the Thomas splint method, plaster shell and Whitman frame. Wherever an abscess forms aspiration alone may effect a cure. When the material by virtue of its thickness cannot be withdrawn, a solution of thymol and camphor ( ) may be injected to produce liquefaction. Paralysis arising from compression responds surprisingly well to fixation.

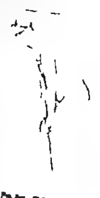


Fig. 805. Child with [illegible] of [illegible] and [illegible] by [illegible] as a result of tuberculous foci in the dorsal region of the spine.

Surgical treatment is generally reserved for the adult patient. Albee, however, urges operation at all ages, the main indications being pain, muscle spasm,

Fig. 806. Demonstrates the normal flexibility of the spine.

increasing deformity, abscess formation and paralysis. Calot is of the opinion that operative procedures in this disease are definitely harmful. American

surgeons in general have favorably accepted spinal osteosynthesis in the treatment of Pott's disease in the adult. The operations of Albee and Hibbs or similar procedures are used (see text).

Albee's Bone Graft Operation for Tuberculosis of the Spine

Fred H. Albee pointed out that in tuberculosis of the spine the only definite curative measure consists of production of ankylosis of the parts affected. In 1909 Albee's first attempts were directed toward fusion of the spinous processes. He was not satisfied with the results obtained and after thorough study concluded that the principles upon which the fusion operation rested were faulty: the spinous processes of the vertebrae offered an insufficient amount of bone to anchor the vertebrae securely, and the low osteogenetic power of the vertebrae resulted in bony unions of little strength. Also, better inoperation as revealed by

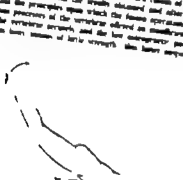


Fig. [illegible] the spine [illegible] result of [illegible]

Albee's experiments on dogs [illegible] and rabbits. Albee solved the difficulty of the problem by applying a strong single graft from a long bone to compensate for the local defects, to supply an bone of high osteogenetic power and by providing immediate immobilization of the affected vertebrae. [illegible] says Albee [illegible] so that the graft of living bone would not only provide immediate mechanical support and added osteogenic power to promote and [illegible] but also act as [illegible] conducting scaffold from the spine to the area and from the uninfected area to [illegible] better circulation might be improved by the effect of the tuberculosis on the blood supply. A diagrammatic representation of the procedure is shown in the accompanying illustrations (Figs. 808-809-810). The removal of the blood supply I have always considered the first step in cure, whether in the treatment of tuberculosis, the arthrodesis of joints or the fusion of spines. Thus the graft lives and increases in size in accordance with Wolff's law has been clearly demonstrated again and again. The physiology of healing bone and of bone grafts has been subjected to rigid investigation in many schools. Some of this work has supported my theses, some has not. Whether the graft has any other

effect than that brought about by an immobilizing influence cannot be stated. It would seem reasonable to attribute the unusual success of the method, in part at least, to the linking up of the osseous circulation in each affected vertebra

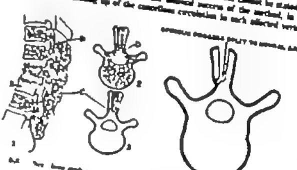


Fig. 808. Albee bone graft operation for tuberculosis of the spine. See description in text. (Courtesy Dr. [illegible])

with that of its neighbor and through the graft with that of the healthy vertebrae adjoining the affected area, as shown in the illustration. At least, it is difficult to account for the phenomenal results on the basis of immobilization alone or

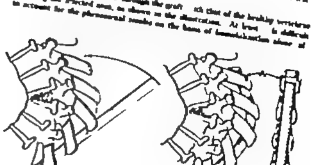


Fig. 809. Albee bone graft operation for tuberculosis of the spine. See description in text. (Courtesy Dr. Fred H. Albee)

though it is realized that complete immobilization cannot be effected in any other way.

Indications and Contraindications. Albee operates on any patient at an age provided the surgical risk is good.

General condition of the patient and operating facilities must be good.

1. Paraplegia, paravertebral and psoas abscess are additional indications for operation.

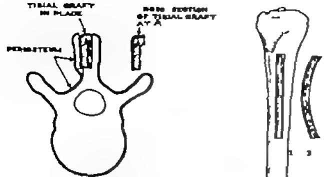


Fig. [illegible]. Albee bone graft operation for tuberculosis of the spine (for description see text). (Courtesy Dr. Fred H. Albee.)

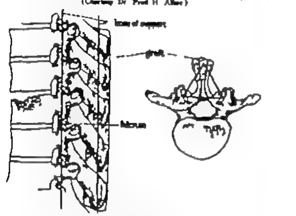


Fig. [illegible]. Albee bone graft operation for tuberculosis of the spine (for description see text). (Courtesy Dr. Fred H. Albee.)

3. High temperature due to secondary pyogenic infection is a contraindication to operation. These should be combated, by blood transfusions and supportive measures, before operation is undertaken. Pyrexia solely due to tuberculosis is not a contraindication to operation.

4. The presence of a second tuberculous focus forms no contraindication to operation.
5. Abscess or sinus are not contraindications. On the contrary, they demand surgery. The field of operation must be thoroughly prepared and sinuses closed with collodion before operation is begun.
6. Any age is proper for operative intervention.

Operation. Correct the kyphosis on a Bradford frame for a varying period. The graft should hold the spine either in the position of deformity to which the disease has progressed or in the position of correction attained prior to or at the time of operation. Albee uses two methods:

(a) the single graft inlay and
(b) the bent single method or the "bundle of rods."

Step 1. Expose the affected area and prepare the spinal gutter by making a median dorsal incision over the tips of the spinous processes from about the last healthy one or two vertebrae above to the first below the affected area.

Step 2. The spinous processes of the involved vertebrae and of two above and two below in the dorsal region (only one above and one below in the lumbar region) are split, in situ, in halves longitudinally almost down to the neural arches. Albee uses a special broad thin osteotome and maintains that the saw is not satisfactory because it is difficult to guide. The soft structures are separated parallel with the muscle between the processes. A greenstick fracture is produced at the base of each of the processes. Pack temporarily the long, gutter-shaped wound with hot lap packs. After one process has been split, Albee anchors one edge of the osteotome in the cleft so as to guide the other edge while it splits the next process above and below. Albee admonishes that: "Care must be taken to fracture only one of each pair of spinous-process halves. If both halves are fractured, the continuity of blood supply through the graft into the vertebral body is interfered with, immediate immobilization of that particular vertebra is not effected and there is the risk that, because of low osteogenic power, union of the fractured spine may not occur and the vertebral body will not secure that mechanical support and vascular rehabilitation which the operation is designed to provide. The gutter for the graft must be bounded by a row of fractured half-spines on one side and a row of unfractured half spines on the other" (Fig. [illegible]).

Step 3. Make an incision over the side of the tibia and reflect the skin so as to expose the crest of the bone. Do not have the skin incision directly over the segment of bone to be removed. Remove with a bone chisel a wedge-shaped piece of tibia with its periosteum intact on two of its surfaces from the antero-internal aspect of the tibia. The section of bone from the tibia must be long enough to reach from the uppermost to the lowest of the split vertebrae and should be about one inch wide, one fifth the diameter of the tibia, and must be of sufficient strength to withstand the strain to which it will be subjected (Fig. [illegible]).

Albee describes the shaping of the graft as follows:

"The shaping of the single graft can be accomplished only to a limited degree. By cutting the upper and lower portions of the graft at an angle to the

rest of its middle portion, which creates the crest, one can secure a graft with greater or lesser curve; but the tibia is not wide enough to provide a single graft suitable for more than a moderate kyphosis. In more extreme cases the bundle-of-rods technic is followed. If the operation is undertaken as early as it should be, the kyphosis will not be too great and a straight tibial graft can be used.

*After the exposure of a sufficient area of the central portion of the antero-mesial surface to provide a graft of the requisite length and diameter, longitudinal cuts are made with the twin saws approximately one-half inch apart, down to the marrow. With the single saw cuts are made between these two, down to the marrow so as to provide four very thin strips. These intermediate cuts fall somewhat short of the original two, so that, when the latter are joined by a transverse cut at each end, the entire graft is lifted out in one piece, with a bridge across each end where the intermediate cuts fall short. This flexible graft is then placed edge-wise in the spinal gutter so that one end of it is in contact with the least favorable end of the graft bed. It is held there with kangaroo sutures through the split supraspinous ligament. A thin strip of bone three-fourths inch long, taken from the side of the gutter in the tibia, is now placed transversely over the top end of the graft and under the supraspinous or interspinous ligament, in close approximation to the two halves of the spinous process, which are stripped of periosteum and recessed to receive it. Having been firmly fixed at one end, the graft is now grasped in a clamp and bent into the gutter and held with interrupted sutures of kangaroo tendon as the molding progresses. The extreme end is held with a transverse locking graft of bone, such as was used to fix the first end. This cross graft is ideal for use with both the shaped graft and the bundle of rods, to prevent any possibility of the end of the graft springing posteriorly out of the gutter. It is used whenever, in the early stages of the disease, straightening of the kyphosis has been attempted either by conservative treatment before operation or by manipulation at the operation. This form of anchorage becomes even more secure as convalescence progresses since the cross graft, being of autogenous, living material, unites with the spinous processes and with the main graft (Fig. [illegible]).

Should the kyphosis be so extensive that the tibia will not supply a long enough graft to fill the gutter, as occasionally happens, the intermediate cuts in the graft may be carried to an entire length, so that the strips are separate. This 'bundle of rods' is then placed in the gutter and fixed at the midpoint with kangaroo tendon; the individual grafts are then telescoped out so as to cover the entire graft bed. One need not be deterred by any fear of the fragility of these strips for even in the adult, if they have been cut accurately with the motor saw, they will bend readily without breaking. Since practically the whole length of the tibia is available as a source of bone graft, this method is resorted to only in extreme cases."

Step 4. Suture the soft tissues over the osseous structures. Close the skin wound. Dress. Immobilize.

Step 5. Close and dress the wound in the leg.

Comment. The originator of the operation warns against technical errors which may jeopardize the results. Meticulous observation to detail

is essential. Modification of the details of the operation as outlined by Albee diminishes its efficiency and may urgently bring it into disrepute.

Commenting on Hibbs' Operation which consists of removing the spinous processes, Albee states: "It cannot be satisfactorily combined with the Hibbs technic because in that operation the spinous processes are cut off. In spite of the interference with the blood supply, the graft might unite with the processes, but, if these did not all unite with the neural arches, there would be a break in vascular continuity and immobilization would be defective."

St. Jacques Method of Osteosynthesis[1]

In order to simplify Albee's operation, St. Jacques removes portions of the ribs instead of obtaining a graft from the tibia. Two cases thus operated upon yielded excellent results. In one case, the cervicodorsal region was affected with pains along the arms. The thoracic wound heals rapidly. There is no need of changing position of the patient during the operation.

Step 1. Place the patient in the ventral position. Make an incision anywhere between the sixth and eighth ribs. Leave a one-half cm. band of periosteum on the anterior surface of the rib thus operated on.

Step 2. No change of position is required because the patient already is in the proper position. Carefully prepare the respective posterior spinal apophyses in a V-shaped fashion for the reception of the rib graft. Place the graft. If the region operated upon is somewhat curved, it may easily be corrected by forcible redressment.

Step 3. Reunite the divided soft tissues with interrupted chromic catgut sutures.

Step 4. Plaster of Paris dressing.

KÜMMELL'S DISEASE

Kummell's disease is a posttraumatic spondylitis of the spine which comes on a few weeks to several years after a back injury and results in a crumbling collapse of a vertebral body with resulting kyphosis. Kummell's original paper described lesions from the third to the eighth thoracic vertebrae although the condition may occur in the lower thoracic and lumbar regions. The disease is usually limited to one vertebra.

The usual history is that of a blow on the back of varying severity followed by recovery, less frequently by definite signs of localized contusion. An interval of symptom free days, months or years pass and then the patient begins to complain of pain, tenderness and weakness over the old site of injury. As the disease progresses the affected vertebra collapses, a kyphosis appears and occasionally paralysis ensues.

Treatment consists of hyperextension by means of a spinal brace, the management in general being that of Pott's disease. With rest and effective immobilization complete consolidation readily occurs and symptoms soon disappear.

SCOLIOSIS

Scoliosis is a deformity of the trunk resulting from a lateral deviation and certain degree of rotation of the spine. The condition results in secondary changes

[1] Canadian Med. Ass. J., April, [illegible]

of the vertebrae, ribs, pelvis, and extremities, and viscera. The thoracic and abdominal organs may be so embarrassed by this shifting as to give rise to distressing symptoms.

The etiology of this disease gives rise to the following classification by Brooke: (1) Congenital, (2) Rachitic, (3) Postural, (4) Paralytic, (5) Functional, (6) Secondary. From the standpoint of pathology the designation of functional and structural types does very well.

Scoliosis when uncomplicated causes the patient little inconvenience. The physician's advice is generally sought as a result of some gross deformity which means that the disease is well established. Cases of lateral curvature occurring before puberty should suggest the diagnosis of scoliosis, especially when it is associated with little pain. In these cases it is most important to ascertain the etiologic factor as a guide in treating the deformity.

In event the condition arises from a functional cause the treatment consists of adjusting faulty school room postures, ill fitting clothes and the like combined with a series of exercises designed to restore tone and strength to the trunk muscles. Lateral curvatures arising from structural causes constitute a complicated treatment problem. The surgeon is dealing with:

Established bony changes associated with malposition of the vertebrae.

Tissue alterations adapted to and tending to maintain the lateral deformity and

Associated postural changes of the viscera and bones making corrective procedures painful and difficult.

Operative treatment of structural scoliosis is to be undertaken with considerable forethought. In general only the adult patient is a candidate. Spinal fusion is the treatment of choice but even this operation fails to give support to the anterior spine. Before any operative procedure the surgeon must correct the existing deformity as much as possible by other means. Among his adjuncts are the MacGee-Sellers and the Abbott jackets, Whitman's frame, halter and right angle countertraction. The most desirable preoperative care is absolute bed rest on a Whitman frame with later application of a Sayre head halter and a weighted pelvic girdle. After six to eight weeks, maximum correction can be expected and the patient is eligible for surgery. Before operation a plaster jacket may be applied so that it will take the outline of correction that the above treatment has provided. This is bivalved and removed before operation, following which it may be reapplied providing stability to the spine and facilitating handling of the patient.

Any operative procedure will be beset with certain difficulties, major among which are:

The extent of the operative field is often very large even as to require two sittings for the procedure.

Structural changes obliterate landmarks and distort anatomic structures. This is especially important as regards establishing the midline in order to keep to the subperiosteal plane and thus preserve a dry field.

Extensive bone grafts are necessary and to obtain and insert them may be often burdensome for someone material. Besides the patient must be handled to bring him into position for both procedures.

The method of operation is very similar to that for Pott's disease although

more extensive. The technic is a matter of personal choice; those of Hibbs, Albee and Kleinberg are a few of the desirable methods. The first two have been described elsewhere; that of Kleinberg is as follows:

KLEINBERG'S OPERATION

Step 1. Estimate the dimensions of the bone graft that will be needed and cut it from the tibia. At ½ inch intervals nick the graft with transverse cuts thus providing flexibility and facilitating bone vascularity. Preserve the graft and close the wound.

Step 2. Place the patient in a prone position, carefully mark out the midline and carry a vertical incision along it over the affected area.

Step 3. Dissect deeply along the subperiosteal plane thus exposing the spines, laminae and finally the entire posterior articulations. These are thoroughly roughened and from the laminae bone flakes are raised and laid as bridges across the interlaminar spaces.

Step 4. Using the technic of Albee split the spines of the two vertebrae above and the two vertebrae below the affected area. Fit the prepared graft into the defects thus produced and force it into contact with the laminae and transverse processes on the concave side of the lateral deviation.

Step 5. Split the spinous processes of the intervening vertebrae and turn them over the graft.

Step 6. Carefully cover all the defects thus produced with periosteum and muscle. Close the fasciae and skin in layers.

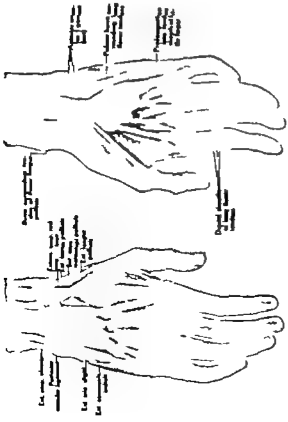
Step 7. Place the patient in bed or in a prepared jacket for one week. After this, traction may be maintained for six months. The patient is then allowed to be up with a light plaster jacket for support. After six months this is removed but the patient kept under supervision.

HAND INFECTIONS

Allen B. Kanavel's many illuminating researches have done much to clarify obscure problems pertaining to hand infections. Satisfactory results are dependent to a great extent upon ascertaining the site of the suppurating focus. A sound knowledge of anatomy coupled with clinical experience are essentials in this important field of surgical activity (Figs. 902–907).

Faced with a case of severe infection of the hand, a careful diagnosis, whether one is dealing with a lymphangitis, tenosynovitis or an infection of the fascial spaces, is paramount in determining the course of therapeutic procedure to be followed.

Lymphangitis is occasioned through a breach in the continuity of the skin which acts as a port of entry for the invading micro-organism. Red streaks, the classical sign of infection, appearing along the lymph paths of the forearm and settle the diagnosis of an existing lymphangitis (Fig. 904). Lymphangitis pure and simple should not be operated on, as surgical intervention tends to promote rapid extension of the process. The patient should be placed in bed and the involved extremity enveloped in a wet dressing. Such a dressing should be warm, wet to a comfortable warmth and should cover the entire affected area. An abundance of fluids must be insisted upon (Fig. 905).



Operation for Suppurative Tenosynovitis

Tenosynovitis arises from an infection of the tendon sheath as a result of direct bacterial inoculation as from a puncture wound or by extension from neighboring tissues. The process tends to spread rapidly and is a destructive lesion. Treatment in the form of immediate and adequate drainage should be provided. Procrastination means the sacrificing of hand or life itself.

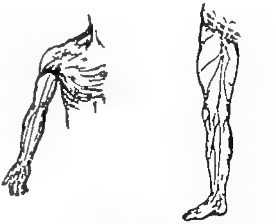


Fig. 904. Course of the main lymphatic trunks frequently involved in the extension of acute lymphangitis.

Where indicated administer a general anesthetic, gas or ethylene oxygen being used.

Step 1. Elevate the arm. Apply a tourniquet a little above the elbow.

Step 2. Make an adequate incision, to one side of the midline of the tendon sheath (Figs. 906–907). Pus often distends the tendon sheath; incise it bilaterally. If frank pus is present and the tendon is visibly affected, sacrifice it; however this should not be practiced routinely.

To prevent infection from being carried into the palm further by the retraction of the cut ends of a tendon, Hamilton Bailey advises suturing these to the periosteum of the proximal phalanx with catgut. Where the tenosynovitis is so intense that gangrene ensues, disarticulate the finger at the metacarpophalangeal articulation. Leave the wound open.

Operation for Tenosynovitis of the Index Finger

Step 1. Make an incision into the sheath of the affected tendon on its radial

Hamilton Bailey: Emergency Surgery. John Wright and Sons, 1936.

side. If the lumbrical canal between the index and middle fingers is involved then the incision is placed on the ulnar side (Figs. 904–906).

Fig. 905. Infected burn followed by lymphangitis four days after burn was sustained. (Surgical Service, Cook County Hospital.)

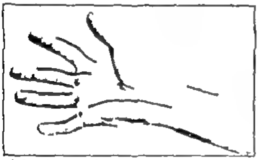


Fig. 906. Lines show regions of suggested incisions for infection of the tendon sheaths. In case of doubt the five incisions of the whole sheath are to be avoided. (Kanavel, Infections of the Hand, Lea & Febiger.)

Step. If pus issues from the lumbrical canal, or if the ulnar side is opened, institute drainage by dividing the web, up to the crease of the distal palmar

flexion. If the radial side has been incised and pus issues from the flexor space, institute drainage by inserting a hemostat to the radial side of the middle metacarpal. The middle palmar space is only rarely infected from the index flexor tendon sheath.

Operation for Suppurative Tenosynovitis of the Middle Finger

Incision. Each side of the lumbrical canal is the more painful; when in doubt incise the ulnar side. Extend the incision down to the distal palmar fold.

Fig. 907. Showing incision for opening the lumbrical space, in connection with the middle palmar space. (Kanavel, Infections of the Hand, Lea & Febiger.)

crease. In cases of recent origin the middle palmar space is not involved; the space between the flexor tendon and the palmar fascia holds the pus and a sufficient of the original incision is extended into the palm (Fig. 907).

If the middle palmar space is infected, institute drainage by introducing blunt pointed hemostats between the ring and middle metacarpal bones sufficiently deep until they project on the back of the hand; cut the skin over the projecting points. Draw a rubber drain through the thickness of the hand and remove it 24 hours later.

Tenosynovitis of the Ring Finger

This is treated in the same manner as pertains in the case of the middle finger except that when a question arises as to which side of the sheath to open, choose the radial side.

Little Finger and Ulnar Bursa

According to Hamilton Bailey the flexor tendon sheath is frequently not connected with the ulnar bursa. Practical experience reveals, however, that communication is more often present than not (Fig. 910).

Characteristic Symptoms of Ulnar Bursitis

In these instances, the palm is much swollen but not enough to completely obliterate the palmar concavity. The portion above the anterior annular ligament is very swollen. Considerable edema is present on the dorsal aspect of the hand. Kanavel's sign (Fig. 90) is observed at the onset, but this disappears in a few days. In the majority of cases, there is communication between the radial and ulnar bursae. Thus, if adequate drainage is not instituted in the ulnar bursa at first, the radial bursa is very likely to become infected.

Fig. 908. Incisions for drainage of infected flexor tendon sheaths. ... Lumbrical canal ... ulnar bursa ... radial bursa ... (After Hamilton Bailey, "Emergency Surgery," John Wright and Sons, 1936.)

Operation for Suppurative Tenosynovitis of the Little Finger

Incise the ulnar side of the tendon sheath over the two proximal phalanges of the little finger. The incision does not extend beyond the finger where the tendon sheath is not included in the ulnar bursa.

Method of Treating Radial and Ulnar Bursa Infection

Pressure exerted on the palmar part of the bursa following the incision will result in pus coming from the lower end of the incision, confirming the diagnosis. (Bailey.)

As shown in the preceding illustration a second incision is made on the radial side of the middle of the hypothenar eminence beginning at the distal flexion crease. Open the bursa by inserting a director into the sheath from above, incising close to the ulnar side. Pus is usually searched for over the portion of bursa which continues over the forearm. Divide the anterior annular ligament. Drainage is instituted. If it is deemed advisable, drain the radial bursa also (Fig. 910).

The radial bursa is a continuation of the flexor longus pollicis sheath. Beginning at the base of the distal phalanx of the thumb, it courses through the eminence, ending under the anterior annular ligament. Its blind termination under the flexor profundus digitorum lying on the pronator quadratus. Symptoms of tenosynovitis of the flexor longus pollicis are characterized

Fig. 909. Infection of the flexor ... from the palm. Dotted line shows the position of the incision along the pus extends far up the forearm. (After Hamilton Bailey, "Emergency Surgery," John Wright and Sons, 1936.)

Fig. 910 Fig. 911

Fig. 910. Incisions for draining suppurative tenosynovitis of the little digit complicated by ulnar bursitis. (After Hamilton Bailey.)

Fig. 911. Incisions for drainage of suppurative tenosynovitis of the flexor longus pollicis complicated by radial bursitis. ... ulnar bursa (Kanavel sign). (After Hamilton Bailey, "Emergency Surgery," Wright and Sons, 1936.)

by [illegible] bending of the distal phalanx of the thumb accompanied by stiffness and pain over the tendon sheath, the greatest swelling being described immediately over the anterior annular ligament. The surgeon should always keep in mind the communication between the radial and ulnar bursae and that there is very little swelling of the palm in [illegible] secondary involvement. Hamilton Bailey urges that both (the radial and ulnar bursae) should be opened together upon the slightest suspicion (Figs. 908-9 [illegible]).

Technic. Incise the tendon sheath of the flexor longus pollicis on the front of the proximal phalanx; continue the incision through the muscles of the thenar eminence. Continue the incision within [illegible] short distance of the anterior annular ligament. Drain.

Fig. 911. Infected front [illegible] of the hand [illegible] of the [illegible] and middle fingers, complicated by [illegible]. (Surgical Service, Cook County Hospital.)

In cases of long standing or where the infection does not respond readily to treatment, it may occasionally be advisable to completely excise the tendon of the flexor longus pollicis; this is preferable to losing the motor nerve to the thenar eminence (Bailey). In addition to the incision already made, make an incision on the front surface of the wrist [illegible] quarter of an inch to the radial side of the midline and on the radial side of the flexor sublimis digitorum. The flexor longus pollicis is identified in the forearm by inserting [illegible] probe along the tendon sheath. Separate and retract the tendon until its muscle belly comes into view. Suture the muscle to the wound and excise the tendon.

Make an incision about [illegible] inches in length an inch and [illegible] half above the styloid process of the ulna, thus avoiding the radial artery. A curved, blunt-pointed artery forceps is inserted in the incision. Open the jaws of the artery forceps which are [illegible] under the flexor tendons across the flexor surface. Where the radial bursa is affected, [illegible] counterincision is made on the radial side of the forearm and the flexor tendon searched for with the surgeon's left index finger. The artery forceps is pushed through the incision until its points are felt by the finger. The distal end of the radial bursa is now punctured. [illegible] similar procedure is followed in the case of ulnar bursa infection (Figs. [illegible]).

Following the operation, bathe the affected arm in hot salt solution. These immersion baths should be frequent (alternating hours). If, as [illegible] result of too much immersion, the hand becomes sodden in appearance, desist from the baths for [illegible] while. Paraffin dressings are warmly lauded by Hamilton Bailey. [illegible]-therapy is a good adjunct. Potassium permanganate irrigations served me well in many of these cases.

Osteomyelitis of an affected finger may be treated by the author's [illegible]-

[illegible] nitrate method (which see) or where urgently indicated, by amputation of the affected digit (Figs. 912-913-914).

Fig. 912. Frozen fingers. [illegible] of [illegible] [illegible] secondary infection [illegible] very [illegible].

Fig. 914

Fig. 915

Fig. 914. Pulp [illegible] on hand followed by gangrene (four fingers fell off spontaneously). [illegible] dry gangrene of the thumb. (Surgical Service, Cook County Hospital.)

Fig. 915. Incision for draining infected terminal pulp [illegible]. The incision should be well up on the side of the finger avoiding the flexor surface. (After Hamilton Bailey.)

Infections of the Fascial Planes

The pulp, thenar, middle palmar, dorsal subaponeurotic, lumbrical, dorsal subcutaneous and hypothenar spaces may become filled with pus.

When pus accumulates in the dorsal subcutaneous space, it is likely to spread all over the hand. Although the purulent collection is in the palm of the hand in almost all hand infections, the back of the hand is often incised by mistake on account of the swollen appearance it presents.

The hypothenar space is quite independent of any other space or tendon sheath and [illegible] unimportant surgically.

Due to pin pricks, etc., the pulps of the fingers and thumbs are more likely to become infected than any other part of the body. The fascial space in this instance reaches from the fingertip to the epiphyseal line of the distal phalanx. It [illegible] very important that the surgeon be thoroughly acquainted with this space because incisions for pulp infections should extend no farther than half an inch from the terminal flexor crease (Fig. 915).

Treatment of Pulp Infections

Hot salt solution baths and fomentations of magnesium sulphate are used until the pulp feels indurated. Place [illegible] rubber tourniquet around the affected finger. Make [illegible] lateral incision, the distal end of [illegible] which is curved. After that continue the fomentations. Irrigate with any good nonirritating antiseptic solution. Frequently the diaphysis of the distal phalanx becomes necrotic [illegible] remove [illegible] (Fig. [illegible]).

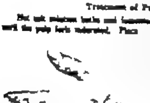


Fig. 916. Infection [illegible] thenar space, dorsal [illegible] resulting from stab wound of [illegible] [illegible]. (Surgical Service, Cook County Hospital.)

Thenar Space Infections

The thenar eminence in these cases becomes edematous, while the metacarpal bone of the thumb is forced away from the rest of the hand. The distal phalanx may be flexed.

The thenar space is bounded by the palmar fascia on the palmar side, by the adductor transversus pollicis on the posterior surface and by [illegible] fascial septum fastened to the middle metacarpal bone. [illegible] fascia [illegible] wall between the thenar and middle palmar spaces (Figs. 916-9[illegible]).

Drainage should be instituted promptly. Make an incision on the back of the hand as shown in Fig. 918, A, [illegible] on the radial side of the metacarpal bone of the index finger. Insert an artery forceps [illegible] across the palmar side of the bone into the thenar space. Do not penetrate beyond the radial aspect of the middle metacarpal. Such drainage is usually sufficient.

The Middle Palmar Space

In this form of infection the hand swells, [illegible] [illegible] slight bulging of the palm is to be noted.

The middle palmar space is bounded posteriorly by fascial fibers which separate it from the interosseous muscles; on the palmar side of the hand [illegible] fascial wall separates it from the flexor tendons of the fingers together with their lumbrical muscles. The fascial septum which is fastened to the middle metacarpal bone separates it from the thenar space on the radial side (Fig. 909).

The lumbrical canals of the middle, ring and little fingers lie in the middle

palmar space. The ulnar bursa lies partly over [illegible] on the ulnar side. Incisions into the palm carry with them the likelihood of infecting the ulnar bursa.

Giving way of the tendon-sheaths of the middle, ring or little fingers may infect the middle palmar space; the latter may also become infected from wounds in the palm of the hand or osteomyelitis of the middle and ring metacarpal bones. Occasionally the space may become infected when the fascial septum between the thenar and middle palmar space gives way in case of thenar space infection.

Drainage is the treatment. This [illegible] accomplished through an incision of the web between the ring and middle fingers or between the ring and little fingers. Never extend the incision beyond the distal flexion crease. In the presence of

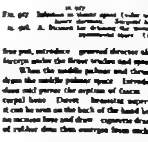


Fig. 917

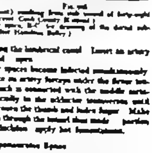


Fig. 918

Fig. 917. Infection in thenar space ([illegible]) resulting from stab wound of forty-eight hours' duration. (Surgical Service, Cook County Hospital.)

Fig. 918. A, Incision for draining the thenar space; B-C, for draining of the dorsal subaponeurotic space. (After Hamilton Bailey.)

free pus, introduce [illegible] grooved director along the lumbrical canal. Insert an artery forceps under the flexor tendon and spread [illegible] apart.

When the middle palmar and thenar spaces become infected simultaneously drain the middle palmar space. Introduce an artery forceps under the flexor tendons and pierce the septum of fascia [illegible] which is connected with the middle metacarpal bone. Direct [illegible] forceps superficially to the adductor transversus until it can be seen on the back of the hand between the thumb and index finger. Make an incision here and draw [illegible] cigarette drain through the tunnel thus made. [illegible] portion of rubber dam then emerges from each incision; apply hot fomentations.

The Dorsal Subaponeurotic Space

Purulent accumulations rarely occur on the dorsal aspect of the hand. Drainage is the treatment. It [illegible] accomplished by two incisions in the inter-metacarpal spaces (Fig. 918, B and C).

Infection of the Middle Palmar and Dorsal Subaponeurotic Space

This type of infection often follows an infected compound fracture [illegible] metacarpal bone or of osteomyelitis. This space is drained by [illegible]

palmar surface of the phalanges. Each sheath terminates just beyond the insertion of the flexor profundus digitorum and there blends with the periosteum of the terminal phalanx.

Dupuytren's contracture (Fig. 932) is the gradual shortening of the palmar fascia causing one or two fingers to become bent (usually the ring and little fingers) though at times it affects all of the fingers. It may involve one or both hands and while its cause is not fully understood the occupation of the individual seems to be about the only place to put the blame. Heredity plays a role.

The characteristic symptoms of this condition are that the fingers are all in flexion; generally it is gradual, however it may be sudden. The hand is quite painful.

Many different operations have been suggested to relieve this affection. Kerr's operation consists in freely dissecting the fascia and its prolongations. Gill complements this procedure by the use of a flap of fascia lata between the

Fig. 932.—Dupuytren's contracture affecting both hands. The patient [illegible] [illegible] years of age.

skin and tendons. The whole surface of the palm may be covered by a full-thickness skin graft after the Italian pedicle method. Complete relief is hardly ever permanent following any treatment, though a great deal of improvement may be attained by interposing, persistent and well directed surgical efforts.

In operating for Dupuytren's contracture the following essentials must be observed (Fig. 933):

1. The skin must be carefully dissected away from the underlying fascia in the area affected. During such dissection, if care is not exercised, the skin will be buttonholed. Liberal undercutting of the remaining skin will usually afford sufficient flaps to cover the denuded area even when the fingers are extended.
2. Thick bands of contracted fibrous fascia must be dissected out.
3. The vincula (prolongations of the fascia running to the sides of the phalanges) should be divided.
4. Correct the deformity.

5. The patient should wear a splint during the healing process. The fingers during this period must remain in hyperextension.
6. Resort to physical therapy early.

Ely points out that when the band of fascia has been excised, no attempt should be made to extend the fingers. In advanced cases this will usually be

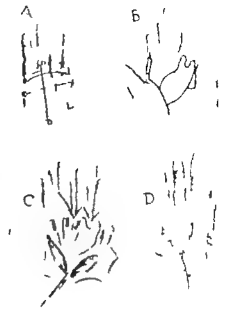


Fig. 933.—Operation for Dupuytren's contracture. A, Incisions to expose the palm of the hand [illegible] Dupuytren's contracture [illegible] [illegible] incision [illegible] [illegible] the middle of the second joint of the finger [illegible] Lexer's [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] (Lexer). C, [illegible] of the [illegible] aponeurosis together with the [illegible] (Lexer). D, [illegible] of the [illegible] of the [illegible] [illegible] placed skin flap to cover remaining defect (Lexer).

found impossible until a small knife has been slid down alongside the first phalanx and the tense vincula divided. Care must be exercised not to divide the blood vessels which run alongside the fingers.

ANOMALIES OF DEVELOPMENT AND TUMORS OF THE SPINE

GENERAL OPERATIVE PROCEDURES

Laminectomy

Terminology. Earlier surgeons employed the term trephining the spine. Some refer to the operation as laminectomy, rachiotomy, resection of the vertebral arches and resection of the spine. However laminectomy is the term used by most surgeons.

Historical Notes. Laminectomy is of rather recent development. Nevertheless, suggestions for the procedure may be found in the writings of Paulus Aegineta

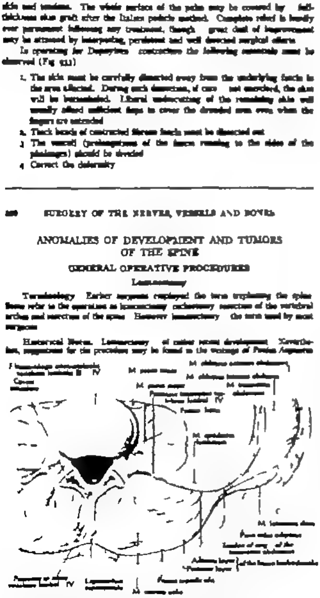


Fig. 934.—[illegible] section through the muscles of the lumbar region. (From Spalteholz: Atlas of Human Anatomy, J. B. Lippincott Company.)

and Fabricius Hildanus. Louis (1762) was apparently the first to remove fragments of a shattered vertebral arch, the result of a gunshot wound. Sir Astley Cooper suggested [illegible] an elaborate procedure which was carried out by Cline (1814) in a case of fracture-dislocation of the eleventh dorsal vertebra. Cline removed two spinous processes and one arch. In this case the spinal cord was almost severed completely and the patient died on the nineteenth day after the operation. About 75 similar operations were undertaken up until 1889 in England and America with rather unsatisfactory results.

Jackson of Sheffield (1882) was first to do a spinal decompression operation with [illegible] results in a case of paraplegia occasioned by spinal caries. Macewen followed suit and advocated laminectomy for paraplegia, thus giving im-

petus to the development of the operation. Gowers and Horsley (1887) removed an extramedullary tumor. Further study of localization of function of various spinal segments and a thorough appreciation of the effects of tumors and disease caused rapid strides in the development of this procedure.

Anatomic Considerations. Thorough understanding of the anatomy of the spinal column, the spinal canal and its contents is a sine qua non to successful operations in this region.

The spinous processes are fairly thin and well separated from one another. Each spinous process can be removed with Liston's bone cutting forceps. In the dorsal region the spines point backward and downward and gradually increase in thickness. They overlap each other to a considerable extent in the upper ten vertebrae. The lower two dorsal and lumbar spines are very short and thick, they are deeply situated between the voluminous prevertebral muscles, and point directly backward. The muscles are thickest in the lower dorsal and lumbar regions (Fig. 934). The blood vessels are not very numerous. Those of the largest size run in the intermuscular septa. The ligamenta flava are very thick particularly in the lower dorsal and lumbar regions. The dura mater enclosing the spinal cord does not contain blood vessels of any considerable size to afford the operator difficulties on that score. However there is a plexus of veins between the anterior surface of the dural sac and the posterior surface of the bodies of the vertebrae. Here troublesome bleeding may ensue in attempting to separate the dural sac from the posterior surface of the bodies of the vertebrae.

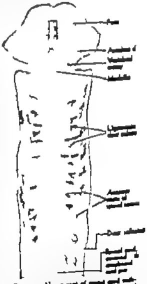


Fig. 935.—Upper part of spinal cord with dural sheath which has been opened and turned aside. Ligamenta denticulata and nerve roots are shown. (From Piersol: Human Anatomy, J. B. Lippincott Company.)

The pia mater closely invests the cord. The arachnoid is separated from the pia by the cerebrospinal fluid. The arachnoid is contiguous but normally not adherent to the inner surface of the dura mater. It is, therefore, usually possible to incise the dura mater without opening the arachnoid sac.

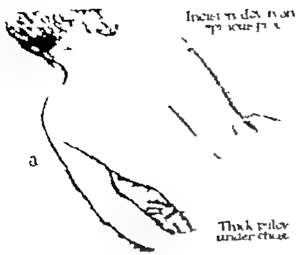
The nerve roots and the ligamenta denticulata hold the cord in place in the spinal canal (Fig. 935). The dentate ligament may be used to rotate the spinal cord in order to expose its anterior surface.

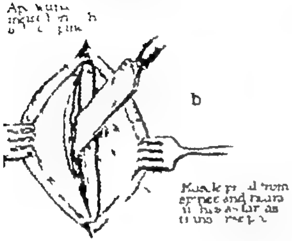
The spinal cord terminates at the level of the lower border of the first lumbar vertebra. It must be remembered that in the cervical as well as in the lumbar region the cord enlarges (cervical and lumbar enlargements). This is important to remember in operating in these areas lest injury to the parts be inflicted.

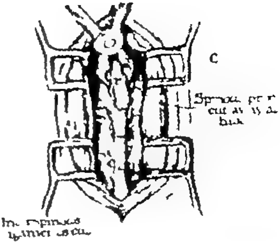
The principal dangers of the operation are hemorrhage, shock, sepsis and impairment of respiratory function.

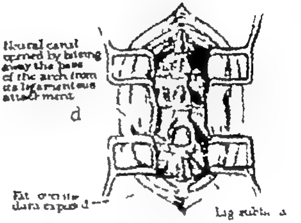
PREPARATIONS FOR OPERATION

Preparation of the patient. Bed-sores should be healed, if at all possible, before undertaking operations about the spine. Prepare the field of operation



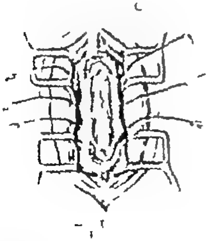






ORTHOPEDIC SURGERY

OPERATION



opening (about [illegible] cm.) is created in the lamina and is made to extend upward to the top of the uppermost lamina to be removed. The fat covering the dura now comes into view. Absence of epidural fat is often the first indication of intradural pathology. Expose the dura. Remove as much of the bone as is necessary in the particular case (fracture, tuberculosis, tumor). Adequate exposure is essential. Remove the laminae close to their attachment. Particular caution is necessary on this point in operations in the cervical region. Hemilaminectomy is often good practice here. Laminectomy is often a bloody operation. The closer one sticks to the bone and the more thorough the stripping of the muscle, the less bleeding. Horsley's wax is used to control bleeding from the cut bone ends. *Packs wrung out of hot saline solution will arrest venous oozing. Never open the dura before adequate exposure is obtained through the removal of several arches.* A bluish cord indicates the presence of blood. If yellowish in color the presence of pus is indicated. Increased tension denotes the presence of a tumor; absence of pulsation indicates interference with the subdural space by adhesions, etc.

Step 7. Opening the Dura (Fig. 998 [illegible]). The dura is opened in the midline with a delicate bladed scalpel over a grooved director inserted into the subdural space. Only fine instruments should be used in this procedure. The dura is opened along the entire length of the defect created by the removal of the vertebral arches. *The cut edges of the dura are held by silk stay sutures* (see illustration) and retracted laterally. Explore. Pathologic conditions are dealt with according to indications.

Step 8. Closure of the Dura. Meticulous hemostasis is essential. The dura is closed tightly with a running suture of fine silk, the stitches being placed about 3 or 4 mm. apart. Dural defects may be patched with fascial grafts. Avoid leakage of cerebrospinal fluid. Painstaking closure of the dura will accomplish this. *The dural sac is drained only in the presence of suppuration.* Unite the overlying erector spinae muscle with interrupted tanned or chromic catgut sutures. The skin and subcutaneous tissues are closed with interrupted silkworm-gut sutures. Avoid dead spaces. Apply voluminous dressings.

Osteoplastic Laminectomy

Donati admonishes that, "if no tumor is found a careful survey is to be instituted for arachnoiditis, large varices of the pial vessels, parasitic infections etc. These may mimic the existence of syringomyelia or sclerosis of the vessels of the spinal cord etc."

Donati objects to classical laminectomy on the ground that it often entails excessive bone destruction and that it is frequently followed by marked loss of blood and untoward manifestations that persist for considerable periods. He prefers osteoplastic laminectomy which he modified and improved.

DONATI TECHNIC

Step 1. Make a curved incision (Fig. 998 a) beginning in the midline, deviating to the right and returning after its curved excursion to the midline again. Between its two points a sufficient area is embraced for the performance of the laminectomy.

Step 2. Detach skin to the aponeurosis (Fig. 998 b). Incise the muscle-

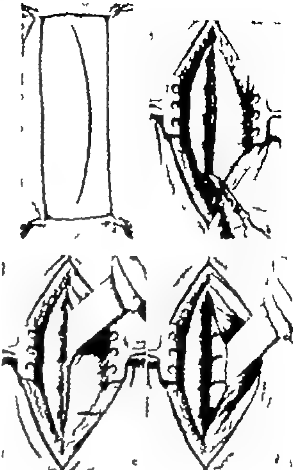


Fig. 998. a, b, c, d. Donati laminectomy. (Courtesy of Prof. Donati.)

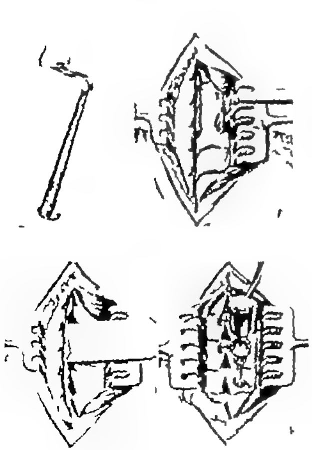
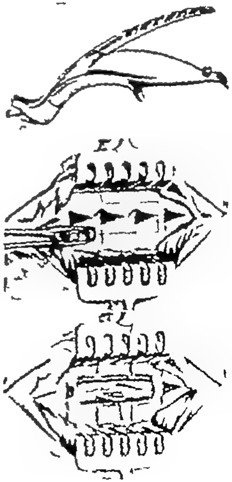


Fig. 998. e, f, g, h. Donati laminectomy. (Courtesy of Prof. Donati.)



periosteal structures on the right side with [illegible] periosteal knife and separate them from their bony attachments (laminae) to the desired length (Fig. 93[illegible] and [illegible])

Step 3. The spinous processes are divided by [illegible] special instrument designed [illegible] Donati (Fig. 93[illegible]) which permits perfect sectioning of the spinous processes by reason of the construction of its blade and the angle at which the latter bites the bone to be divided (Fig. 9[illegible]). The blades of the instrument are of various sizes to suit [illegible] given case (Fig. 93[illegible] f and g). After the desired number of spinous processes have been removed the procedure of separating the musculo-aponeurotic structures is repeated on the left side of the spine.

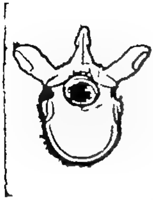


Fig. [illegible] Donati instrument. (Courtesy of Prof. Donati)

Step 4. The laminae are next undercut with [illegible] Doyen or de Martel drill (Fig. 93[illegible] h) creating [illegible] large enough opening to permit the introduction of the lower jaw of the Donati instrument by which the section of the desired osteoplastic flap is accomplished (Fig. 93[illegible] i). The laminae are readily sectioned. The flap thus produced permits its displacement in one piece (Fig. 93[illegible] j and k).

Step 5. The spinal operation is completed and the dura closed, the osteoplastic flap is replaced and kept in position by interrupted or continuous sutures.

Exploration of the spinal column without weakening it is effectually accomplished by this procedure.

Gonzalez [illegible] Simplified Technic in Laminectomy

The important feature of this procedure is that instead of stripping the soft parts and the periosteum from the posterior vertebral spines on either side and then cutting off the spines at their bases, the spines are split longitudinally into right and left halves similar to the Albee operation for insertion of [illegible] bone trans-

plant in Pott[illegible] disease except that the halves are deflected on both sides instead of one. This facilitates the separation of the periosteum with attached soft parts from the laminae laterally as far as the articular processes. The posterior spines are split down to their bases, leaving only [illegible] small remnant which is cut away with bone-cutting forceps.

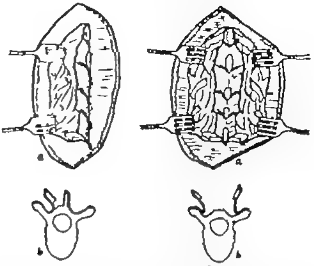


Fig. [illegible] Fig. [illegible]

[illegible] Posterior spinous processes [illegible] split in the middle, the left halves are deflected with the periosteum, leaving the denuded laminae [illegible]; the right halves [illegible] [illegible] (Courtesy Jour. Amer. Med. Assn.)

Fig. [illegible] Divided spinous processes [illegible] deflected on both sides, exposing denuded laminae on both right and left [illegible] (Courtesy Jour. Amer. Med. Assn.)

Step [illegible] Make [illegible] curved incision to one side of the row of posterior spinous processes through the skin and subcutaneous tissue. Reflect the flap [illegible] exposing the deep fascia on either side of the midline.

Step [illegible] Make [illegible] straight incision with [illegible] knife down the midline splitting the supraspinous ligament and ending or at least marking the tips of the spinous processes themselves (Fig. [illegible]).

Step 3. Insert [illegible] knife between the individual spinous ligaments, split the spines with [illegible] very fine chisel through the line indicated, keeping as close to the midline as possible. Drive the chisel slightly to one side at the base of the spinous process. Retract the corresponding halves and deflect to one side.

Step 4. Strip the periosteum from the corresponding laminae to the articular processes with [illegible] gauze sponge over [illegible] periosteal elevator. Brush off the [illegible] halves of the posterior spines close to their bases with [illegible] chisel, deflect them to the side and strip back the periosteum (Fig. 9[illegible]).

Step 5. Bite off with suitable forceps the remnant of the bases of the spinous processes and cut through the laminae. Remove the laminae and deal with the spinal contents as conditions warrant (Figs. 9[illegible] a, and b).

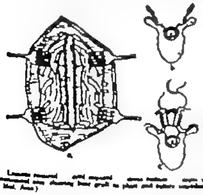


Fig. [illegible] Laminae removed [illegible] [illegible] [illegible] [illegible] showing bone graft in place and sutures [illegible]. (Courtesy Jour. Amer. Med. Assn.)

Step 6. Closure of the wound is simple. If the split spines are not too thick insert [illegible] stout, full-curved cutting needle through the corresponding halves, securing them in apposition. This [illegible] not absolutely essential as they will be held by the sutures of the periosteum and deep tissues above and below (Fig. 9[illegible]).

Comment. The chief advantages of this method are the speed, diminished trauma, lessened hemorrhage and better closure.

In some instances it may be necessary to fix the spine with [illegible] tibial transplant after decompressing the cord, which is accomplished very satisfactorily following this method of treatment.

SPINA BIFIDA

This condition is due to an abnormal congenital opening in the posterior part or laminae of one or more vertebrae and comprises [illegible] number of varieties, the best known being spina bifida occulta and the meningocele (Fig. 9[illegible]). In spina bifida occulta there is [illegible] cleft in one or more of the spinal vertebrae but no protrusion of the spinal cord or membranes. In the various meningocele forms

Fig. 9[illegible] Spina bifida (meningocele). Baby, [illegible] days old.

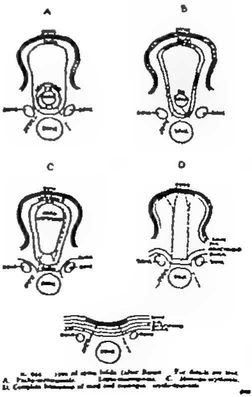


Fig. 9[illegible] [illegible] types of spina bifida (after [illegible]). For details see text.
A. [illegible] B. [illegible] C. [illegible]
D. Complete [illegible] of cord and meninges [illegible]

either membranes or cord or both protrude through the vertebral cleft and form a protruding sac. Here there are defects in both the posterior osseous wall of the spinal canal and in the dura (Fig. 944).

The most generally adopted method of dealing surgically with spina bifida with a sac is by excision of the excisable portions of the sac, the returnable medullary parts being returned to the spinal canal, and the protection of the gap by means of superimposed flaps of muscle, fascia and skin. Many myeloceles are inoperable.

Of the many technics devised by various authors, the methods of Fraser are given here. In the first method, personally devised by Fraser, the sac is exposed by a U-shaped flap, incised, and its contents examined and, if returnable, the medullary portions are returned into the spinal canal. The hernial sac is then excised at its neck. In this procedure, after excising the sac and closing its mouth an incision is made in the erector spinae muscle around the margins of the hernial opening, extending an inch or more above and below the orifice. If the sheath of the muscle and the muscle itself cannot be approximated without undue tension, vertical incisions are made in the aponeurosis of the muscle near its outer origin thus sufficiently relaxing tension to make approximation in the median line possible.

A second method in which the names of Fraser and Bayer are associated is characterized by reflected flaps of the aponeurosis. In this procedure curvilinear incisions are made on either lateral aspect of the hernial opening, over the erector spinae muscle, forming an ellipse which enable the surgeon to form flaps having their bases toward the spinal opening. If possible, without endangering the nutrition of the aponeurotic flaps, incisions are made along the margins of the hernial orifice as in Fraser's first method, so that the muscular structures can be mobilized in order that they may be used to reinforce the aponeurosis. This method may be modified so that instead of forming the lateral flaps, a U-shaped flap is formed, the upper aspect raised from the wound with the base downward after mobilization of the muscles. This modification is reserved for cases in which material for lateral flaps is inadequate or is not available so that great tension would be encountered.

Spina Bifida Occulta

As there is no protruding herniated mass in this condition, operation may very frequently be dispensed with. However, if symptoms occur from mechanical pressure or any other cause, some attempt should be made to close the bony cleft by an osteoplastic or osteoplastic operation. Large bony defects have been effectively closed by muscle flaps alone.

Meningocele

One variety of meningocele appears as an anomaly of the posterior bony structures of the spinal canal. The spinal membranes, skin and cord are affected. Hernia of the dura takes place through the aperture and the subdural space contains a quantity of fluid (Figs. 943-944 A and B).

Another variety has the same characteristics as the one described above except that the fluid is found in the subarachnoid space and the arachnoid is involved in the hernia.

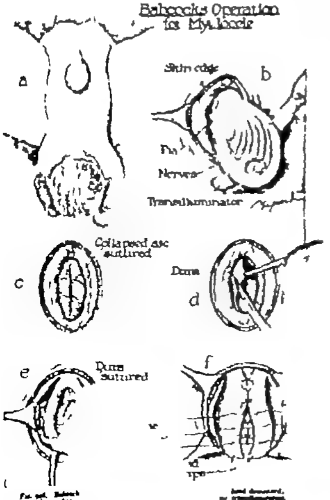


Fig. 948. Babcock [illegible] ... dura sutured, ... by transillumination ... of the affected ... Dura sutured over ... flaps for ... [illegible]

A third variation affects the dura as well as the bone and the hernia protrudes through these defects, the hernia being made up of the arachnoid and fluid.

Myelo-cystocele

This appears as an abnormality in the posterior bony structure of the spinal canal and part of the dura. The pia and arachnoid are unaffected. Fluid distends the central canal of the spinal cord so that a hernia appears, the sac of which is formed by the arachnoid and pia. Due to distention, the cord is spread in a thin layer over the interior of the sac (Fig. 944 D).

Myelocele

This abnormality involves the skin, posterior bony wall of the spinal canal and corresponding parts of the dura, arachnoid and pia. The back surface of the cord is either split or obliterated. The middle canal of the cord is exposed to the air. The collection of fluid is between the pia and arachnoid anterior to the cord material. If fluid collects in the arachnoid it will form part of the sac and the nerve roots will project forward in the wall of the sac (Fig. 944 C).

Fig. 945. Spina bifida. Position of patient for operation. [illegible]

Another variety of myelocele has the same characteristics as those described above except that there is no fluid formation. The remaining cord substance is continuous with the skin and lies in a furrow in the back. The meninges are a continuation of the subcutaneous tissues.

Surgical intervention is contraindicated in cases of myelocele or in spina bifida complicated by paralysis or serious abnormalities of the cord substance, also in cases of severe hydrocephalus or abdominal or visceral fistula.

Step 1. Place the patient in position shown in Fig. 945. Make two skin flaps from the base of the growth large enough to cover the opening which remains after the sac is removed.

Step 2. Make a transverse incision in the sac but do not extend it over the apex of the tumor.

Step 3. Explore. Ascertain whether or not the nerves are enveloped in the walls of the sac. If they are not, trace them to their source in the medullary substance forming part of the sac. The latter is separated from the sac of

the sac and reduced into the spinal canal. Excise the redundant portion of the sac. If meningocele is present, suture the base of the sac and reduce it.

Step 4. Unite the edges of the wound with deep and superficial sutures.

BABCOCK'S OPERATION

Place a blanket on the headpiece of an operating table and fasten it tightly. Hang the child over this by its groins (Fig. 948). Place a hot water bottle opposite the child's abdomen to prevent chilling. Have the assistance of a trained anesthetist. Pure carbolic acid followed by alcohol is used to sterilize the affected region. The entire region is painted with tincture of iodine.

Step 1. Inject 30 mg of novocaine or 10 mg of cocaine, dissolved in [illegible] of sterile 70 per cent alcohol, into the cephalic portion of the sac. Inject slowly so as to ensure thorough mixing of the analgesic with the cerebrospinal fluid.

Step 2. Dissect all ulcerated or ulcerated parts and meninges apart. Ascertain the location of the nerve filaments and spinal cord so as to avoid them. Liberate and retract the skin from the sac (Fig. 948 b).

Step 3. Pierce the sac. Resect the sac or if conditions permit, let it collapse into the spinal cavity. Fix the sac with a continuous fine chromicized catgut suture so that it cannot unfold (Fig. 948 c).

Step 4. Divide the dural border ... with the inner surface of the ... lamina and separate it from ... (Fig. 948 d). Enlarge the dural canal by suturing the ... the cord.

Step 5. Expose the borders of ... and incise the laminae with bone forceps. This forms ... flaps on either side of the abnormality. These strips ... (Fig. 948 e).

Step 6. Two flaps of tissue ... are formed from the ... the midline. Unite ... tion, incised above and below. The two flaps are sutured in ... with mattress sutures so that ... there is no leakage and necrosis ... is unlikely (Fig. 948 f).

Based upon his ... through ... authors, Arnold ... at the follow...

...th spinal ... spinal ... particular ... upon ... technic is ... follows ... first should ... is of ... followed as ... and ... to the ... of ... the ... tract ... of ... and ... The ... thes

position marked on the skin surface. The surgeon must be thoroughly informed not only about the [illegible] condition of the patient but of his general physical condition as well.

The patient is placed for operation in prone position with the head and upper part of the body lower and the side to be operated on higher. This, for the purpose of avoiding excess loss of cerebrospinal fluid. While some do not consider such loss of cerebrospinal fluid of much importance, Jirasek as well as von Eiselsberg, consider it unnecessary and even dangerous. The experimental work of [illegible], Gordon and [illegible] (1931) have proved Jirasek's doctrines to be correct, and while the latter perform the operation described for operative intervention, Stookey, Ball, von Eiselsberg and [illegible] operate with the patient in the lateral position while de Martel and Leriche perform the operation with the patient in sitting position. Jirasek prefers local infiltration anesthesia which he states is most satisfactory. He condemns intravenous [illegible] as an anesthetic for the reason that it causes increased venous bleeding. Heymann used avertin, 0.1 gm. to a kilogram of the patient's weight, with success, combining this form of anesthesia with local infiltration analgesia and ether inhalation. The incision is made with a scalpel and is longitudinal, overlying the entire area to be operated upon with its convexity toward the surgeon. The muscles are separated from the vertebrae in the midline with an electrosurgical knife. The back portions of the vertebrae are removed completely. Osteoplastic methods are not resorted to except in unusual cases such as where one has to operate in the region of the last cervical and the first two thoracic vertebrae where the spinal cord would not be sufficiently protected after the operation from the displaced soft structures only (Heymann), or in places where the final thoracic portion of the spinal column passes into the free lumbar region (von Eiselsberg). Jirasek does not use a chisel or electric [illegible]. His instrumentarium consists exclusively of Luer forceps.

The bone is removed laterally as far as is necessary for thorough exposure (in the region of the tumor as far as the intervertebral articulations). While formerly, Jirasek was an ardent advocate of hemilaminectomy he no longer resorts to its use.

Bleeding may become very troublesome during the process of removing the bone, not so much from injury to the vertebral artery when one is operating on the cervical spine ([illegible]) but from the veins. Such bleeding is not only hampering to the progress of the operation but may become actually dangerous because of the possibility of air embolism ([illegible]). Such hemorrhages result from the veins coming from the inner vertebral venous plexuses and from the circular and longitudinal sinuses from which the blood passes through unusually stretched veins which are firmly attached to the periosteum surrounding the intervertebral space. By reason of their peculiar anatomic disposition, these veins do not collapse, but constantly hold their lumina open. The negative pressure under such circumstances causes aspiration of air which is most marked in the upper part of the azygos veins. According to [illegible] the area most exposed to air embolism is the region between D III and D V on the right side especially. Particularly is this true when the operation is performed under general anesthesia. Jirasek stresses the fact that the only way to avoid injuring these veins is to use Luer forceps in such a manner that the lower branch of the instrument is inserted close to the bone and while so doing pushes

the veins aside. When such hemorrhage does take place it should be stopped by compression with a piece of muscle taken from the wound or as suggested by de Martel, with bird muscle. The surgeon should consider the number of vertebrae to be removed, particularly when operating in the cervical or lumbar regions (Frazier). Jirasek removed from the thoracic region as many as nine vertebrae without inconvenience to the patient. Lehmann removed ten vertebrae. Great caution should be exercised in the borderregion between the cervical and thoracic and between the thoracic and lumbar areas of the spinal cord.

The surgeon should note with much care the fullness and tension of the dura and its movements as related to respiration and pulse beat. If after thorough inspection and very gentle palpation it does not appear clear whether the tumor is definitely situated in the field of operation, Jirasek's two-needle test is resorted to. In this test two needles of equal size are thrust into the dural sac in the upper and lower portions of the field of operation. The movements of these needles and the out flow of the cerebrospinal fluid is then carefully noted. One of the advantages of this test is that until proper localization of the tumor has been made the dura remains closed and the loss of cerebrospinal fluid, hampering to the operative maneuvers, is avoided. It also circumvents the danger of sudden loss of cerebrospinal fluid. It is evident that with a closed dural sac there is less danger of injuring the spinal cord inadvertently than when the cord is laid bare. Jirasek described this test first in 1930 before the introduction of Sicard's test. It is based on the observations made by Becker, Ayer, Queckenstedt, [illegible], Weigeldt, Stookey and others.

Conclusions to be Drawn from Jirasek's Two-Needle Test. 1. If cerebrospinal fluid issues under the same pressure and at the same rate from both needles and both pulsate, there is either no tumor present or it is so small that it does not encroach much upon the subarachnoid space. Under such conditions, open the dura.

2. If both needles remain quiescent, the cerebrospinal fluid flows from them feebly and under low pressure or perhaps, no cerebrospinal fluid issues at all, the conclusion to be drawn is that either the needles have entered the tumor itself or have penetrated the space occupied beneath the tumor. Under such circumstances the opening in the spine should be enlarged in an upward direction.

3. Where the upper needle pulsates and the cerebrospinal fluid flows under normal or increased pressure and the rate of flow is more rapid than from the lower needle which pulsates little or not at all, open the dura.

4. If the cerebrospinal fluid issues from both needles with the same rate of rapidity, the upper needle pulsates and the lower one does not, one concludes that a tumor is situated between the needles; the dura may be opened.

5. If no fluid at all issues from the upper needle while from the lower appears first under pressure and then slackens, the conclusion is justified that the upper needle has either entered the tumor or the ligament. Under such conditions after slightly enlarging the opening of the bone in an upward direction, the dura can be opened.

In conjunction with the Jirasek two-needle test, the Queckenstedt test may be carried out. To obtain exact results the needles must be of the same length (about 5 to 7 cm.) of the same width, equally ground, perfectly smooth within and without and manufactured of the same material. They must be inserted in

exact relationship to the region explored with the patient in a horizontal position. Jirasek has observed no ill effects following his test. [illegible], Jirasek's test is not applicable neither should it be resorted to in cases of [illegible] of the cerebrospinal fluid or blood, nor can it be applied in cases where a tumor separates the spinal from the cerebral system. Jirasek used this test in thirty-one cases. Fifteen of the patients were affected with tumors and sixteen suffered from other intravertebral diseases. In spinal tumors he obtained definite information in fourteen out of fifteen cases. In the one remaining case the result was indefinite and in no instance gave the misleading information. While no test is infallible, Jirasek's two-needle test, in certainty of diagnosis, value in diagnosis of intraspinal tumors and as a guide to proper operative procedure, [illegible].

When the two-needle test is positive, one can immediately open the dural sac and arachnoid. [illegible], the dura and visceral leaf of the arachnoid is opened by the Elsberg method. No matter where the tumor is located, it is gently drawn aside by means of [illegible], tape or by injecting water at the base of the tumor. Where the neoplasm is located in the intramedullary portion of the spinal cord, one or two posterior nerve roots which are hindering the operative procedure have to be divided. Cocaine-block as recommended by Frazier is of definite value especially in extramedullary tumors. The question of whether to operate in one or two stages has to be decided according to the location of the tumor, its size, contour, depth, nature, etc. If the operation is performed in one stage, it is essential to carefully watch the blood pressure during the operation and the action of the heart and to interrupt the operation at once if alarming symptoms threaten.

According to Jirasek, packing of the subdural and epidural spaces is more dangerous than hemorrhage when the operation progresses well. However, packing is of special importance when multiple tumors are suspected. Jirasek points out that the practice of certain American surgeons who recommend an estimation of the permeability of the spaces above the removed tumor by means of the Queckenstedt test at the conclusion of the operation may not give definite information particularly when much of the cerebrospinal fluid has been lost during the operation. The dura is closed with silk thread. Before closure, however one must ascertain whether the conditions of pressure are normal ([illegible]). When the spinal cord is very edematous following the removal of tumors, the dura is left open; also no closure of the dura is attempted when there is danger of bleeding in the bed of the tumor or when the tumor cannot be removed in its entirety or in cases of malignant tumors, particularly when they are to be subjected to radiation therapy. It is better to resort, in such instances, to decompressive laminectomy. The admonition of von Eiselsberg (1930) that such decompressive operations are justifiable is opposed by Jirasek because of his experience that not all cerebrospinal fluid fistulae proved fatal.

The muscles should be sutured with two rows of sutures. Following the operation the patient must remain in a horizontal position. Extension of the head and lower extremities is resorted to only when the bodies of the vertebrae are damaged. In patients where the operation was not of great severity Jirasek allows them to get up after about ten days or a fortnight. Otherwise the confinement is prolonged. In cases where fixation of the spinal column is indicated by reason of loss of support, one may resort to spinal fixation of the Albee type or to the [illegible]-Jirasek method of arthrodesis of the intervertebral joints.

In inoperable malignant tumors in this locality particularly where patients suffer from constant pain which cannot be relieved by other means, cordotomy is recommended by Spiller. This is best performed at the level of D IV-D V

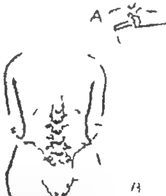


Fig. [illegible] Lumbar puncture. A, diagrammatic representation of [illegible] introduced by needle [illegible] in the subarachnoid space [illegible] in lumbar puncture [illegible] the sitting posture. (After [illegible])

Fig. [illegible] Lumbar puncture with patient [illegible] the lateral [illegible] posture. [illegible]

([illegible]) or D VI (Foerster). When properly performed the results are complete analgesia. Where continuous root pains cause incessant suffering, rhizotomy (page 112) may be resorted to.

[illegible]

PILONIDAL CYSTS

[illegible]

[illegible]

[illegible]

OPERATIONS ON TENDONS AND TENDON SHEATHS

TENOTOMY

[illegible]

Open Tenotomy

[illegible]

A B

[illegible]

Subcutaneous Tenotomy

[illegible]

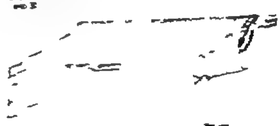
Subcutaneous tenotomy is preferred because of

1. lessened danger of infection and
2. elimination of scar

[illegible]

Tenotomy of the Tendo Achillis

[illegible]



[illegible]

[illegible]

Lengthening of Tendons

[illegible]

Shortening of Tendons

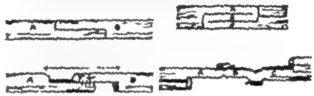
[illegible]

TENORRHAPHY (TENDON SUTURE)

[illegible]

(a) End-to-end suture.
(b) Side-to-side suture.
(c) Lateral implantation.

[illegible]



[illegible]

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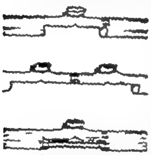
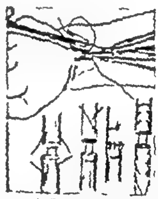


[illegible]

[illegible]

[illegible]



Secondary Tendon Suture

[illegible]

[illegible]

[illegible]

Lumbar Puncture

The technic of puncturing the lumbar subarachnoidean space for diagnosis or therapy is practically the same as that for spinal anesthesia. The patient may be either in the sitting or obliquely reclining posture. (Figs. [illegible])

Step 1. The skin is thoroughly prepared and the immediate area infiltrated with a few drops of [illegible] % novocain solution. The tip of the spinous process of the fourth lumbar vertebra is marked by the left index finger.

Step 2. The surgeon now introduces a special graduated exploratory needle at a point about [illegible] cm. to the right and just below the tip of the spinous process; the needle is made to penetrate slowly in a direction forward, inward toward the median line and slightly upward into the interlaminar space between the fourth and fifth lumbar vertebrae. (Fig. [illegible]) The entrance of the needle into the subarachnoid space should be recognized by the lessened resistance. The needle usually traverses a distance from skin to subarachnoid space of about ½ to 3 inches. When the needle enters the subarachnoid space, clear cerebrospinal fluid will appear either in droplets or in a stream. A suction syringe needle may be employed instead of the exploratory aspirating needle.

Step 3. The free-flowing cerebrospinal fluid is caught in a suitable sterile receptacle (preferably three sterile test tubes) and not more than from 10 to 30 cc. is withdrawn at a time. The needle is then withdrawn and the puncture site closed with sterile zinc oxide plaster or collodion.

Cisterna Puncture

This procedure resembles in part a lumbar puncture but the space entered *is that portion of the subarachnoid space termed the cisterna basalis*. It is utilized mainly for diagnostic purposes and for administering therapeutic serums in meningitis.

Step 1. *Shave the "nape" of the neck from the external occipital protuberance downward.* Surgically prepare the skin of this area. Place the patient on his side and flex the neck. Have an assistant hold patient's head firmly.

Step 2. Visualize a line which passes backward from the glabella through the *external auditory meatus thus clearing the upper border of the foramen magnum.* Palpate the spine of the axis, and infiltrate the area immediately above it with [illegible] % novocain solution. Insert the exploratory needle just above the spine of the axis and in the midline. Cautiously advance the needle along the *line of direction previously visualized. At a depth of [illegible] to 1½ inches the "give"* of the dura indicates that the subarachnoid space has been entered. Once through the dura further advancement must be absolutely prevented.

Step 3. Spinal fluid escapes as in a lumbar puncture and the subsequent procedures are the same.

PILONIDAL CYSTS

Postanal Dermoid

The condition is also referred to as pilonidal sinus, pilonidal fistula, sacral dermoid, postanal fissure and sequestration dermoid. Pilonidal cysts are forma-

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tions containing hair which occur at the base of the spine around the sacrum. The condition is congenital. A small fistula or sinus often connects these cysts with the skin. The sinus opening very often occurs between the end of the coccyx and the anal canal, coursing upward toward the lower end of the sacrum or coccyx. Its location has occasionally been responsible for the wrong diagnosis of fistula ano. In some cases there are numerous openings leading into cystic cavities. These sinuses are prone to infection and when once infected are very troublesome. Patients, as a rule, are unaware of the existence of the condition until infection becomes manifest, usually between the second and third decades of life. Lateral openings are often found discharging pus. Incision and drainage, curettement and cauterization are often resorted to, to cure the condition but they prove ineffective. Complete excision is called for to obtain a cure.

Fig. [illegible]. Pilonidal cyst. [illegible]

Both sexes are affected but it is more frequent in males. It is rare in negroes. Short hairs are often seen projecting from the openings. A probe or palpation will rarely give a true picture of the extent of the condition. Cysts and cavities are usually deep-seated, the sinuses lying close to the periosteum; the cavities are often multiple.

Palliative measures, as stated, are useless to effect a cure. Prior to operation, explore the sinuses; inject the tracts with methylene blue.

Preceding surgery the proposed operative site should be given special cleansing attention for several days. A very excellent solution for this purpose is that of Scott (Mercurochrome [illegible], acetone [illegible], alcohol (95%) [illegible], distilled water [illegible]).

Operation. General anesthesia, low spinal or occasionally block infiltration.

Step 1. Make two lateral elliptical incisions as shown in Fig. [illegible]. Extend these incisions to the depths sufficiently to embrace the entire affected area en bloc. See to it that not the slightest vestige of cyst remains. If left behind, recurrence will be the rule.

Step 2. Primary union may now be attempted. All dead spaces must be obliterated. This may be secured when the cyst is small, the wound clean and asepsis assured.

Tension on the sutures is often excessive; however, the wound may become infected, calling for immediate removal of the sutures.

In the vast majority of cases, the best results are obtained by judicious packing of the wound and unprecipitated closure of the tegumentary segments.

I prefer to dissect down to the bone and undercut the flaps bringing them into easy apposition and thus shortening the time of healing.

Rigid asepsis is imperative. I prefer to lock up the bowels for a few days to avoid possible soiling.

OPERATIONS ON TENDONS AND TENDON SHEATHS

TENOTOMY

This consists of division of a tendon transversely. Tenotomy is used mainly when a tendon is too short, giving rise to deformity. The operation may be performed either by the

(a) open method or by the
(b) subcutaneous operation

Open Tenotomy

Thoroughly expose the parts to be divided by a lateral incision running parallel with the tendon. Tenotomy knives are used for the purpose. The section of tendon to be severed is divided and the wound closed.

A B

Fig. [illegible]. A. Subcutaneous tenotomy of the tendo Achillis. Note that the tenotome [illegible] parallel to the direction of the tendon from its anterior surface. B. The cutting edge of the tenotome [illegible] now directed perpendicularly to the tendon; the tendon [illegible] by dorsiflexing the foot and [illegible] then [illegible] through by sawing motion is indicated. Note that the thumb palpates the subcutaneous portion of the blunt edge of the tenotome. (After [illegible])

Subcutaneous Tenotomy

Small narrow bladed tenotomes are used for the purpose. Short, narrow bladed instruments, sharp or probe pointed are used, depending upon existing conditions.

Subcutaneous tenotomy is preferred because of

lessened danger of infection and
elimination of scar

Introduce the tenotome through the skin down to the tendon to be divided. Withdraw. Introduce a blunt pointed knife along the track thus made, turn the cutting edge toward the tendon to be divided, put the latter on the stretch and with a sawing motion divide the tendon. When important structures are placed [illegible] y by the subcutaneous method the open procedure should be resorted to.

)

Tenotomy of the Tendo Achillis

Step 1. Place the patient face downward and antiseptically prepare the limb to be operated on. Palpate the position of the tendon to be severed, locating its most accessible part.

Step 2. Introduce a sharp pointed tenotome anterior to the tendon (Fig. [illegible] A). Turn the cutting edge of the tenotome toward the tendo Achillis. Flex the foot, making the tendon tense. Avoid perforating the tendon while introducing the knife.

Step 3. Divide the tendon by a see-saw motion, avoiding injury to the skin (Fig. [illegible] B).

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Tenotomy of the tibialis anticus tendon proximal to its insertion and [illegible] the [illegible] ligament.

Fig. [illegible]. Open tenotomy of the tibialis posterior tendon above the internal malleolus avoiding the posterior tibial vessels.

Step 4. Withdraw the knife. Dress and maintain the foot and leg in the corrected position.

Tenotomy of the Tibialis Anticus

Abduction and plantar flexion show the position of the tendon which [illegible] divided near its insertion into the internal cuneiform bone. A tenotome is introduced through the skin a short distance from the proximal edge of the tendon. Turn the knife toward the tendon; divide it (Fig. [illegible]). Withdraw the knife. Close the wound.

Tenotomy of the Tibialis Posticus

Divide the tendon about [illegible] inches above the internal malleolus. Recognize the tendon by abduction and plantar flexion of the foot (Fig. [illegible]). It [illegible] usually divided together with the tendon of the flexor longus digitorum. *Avoid injury* to the posterior tibial vessels.

Peroneal Tendons

These tendons are divided just above the base of the external malleolus. The operation is done subcutaneously; the tenotome is introduced close to the fibula between the tendons and the bone.

Biceps Cruris

The division of this tendon is performed by an open operation in order to avoid the external popliteal nerve which is exposed to injury while doing the subcutaneous operation (Fig. 991). The incision is carried in the direction of the tendon just above its insertion into the fibula.

Semitendinosus and Semimembranosus

These are divided just above the knee joint. The operation is usually performed subcutaneously.

Fig. 991. Course of the biceps cruris muscle and the knee on its tendon.

Sternomastoid (Torticollis)

Subcutaneous and open operation.

SUBCUTANEOUS OPERATION

This operation leaves no visible scar. Its chief drawback lies in the fact that important structures may inadvertently be injured. The sternal head of the muscle is easily managed. tenotome is introduced to it beneath the skin, incise the tendon from before backward; the clavicular portion should also be divided (Fig. 992).

OPEN OPERATION

This procedure avoids the danger of injury to contiguous structures, but leaves visible scar. Rotate the head toward the sound side. Beginning at the outer edge of the sternal attachment of the muscle, an incision of ½ inches in length is made. Divide the tendon completely including any restraining fascial bands. Careful hemostasis (Fig. 993).

Overcorrect (Lorenz). Immobilize the head in plaster of Paris, sandbags or other apparatus. Retain the position by an extension apparatus or collar.

Torticollis may also be remedied by muscle lengthening (the well-known Thomas operation) or by myomectomy (Mikulicz operation) which consists of excising the lower two-thirds of the sternocleidomastoid muscle preserving the upper third to avoid injury to the spinal accessory nerve.

Lengthening of Tendons

This becomes necessary when loss of substance of tendon causes its shortening. The Z-operation is one of simplicity. Figure 996 illustrates the technical details of the procedure. It consists principally of splitting the tendon longitudinally into two halves for a sufficient distance and then cutting half through on either end of the split in opposite directions. Other methods are shown in Figs. 997-998.

Shortening of Tendons

This is usually done in various forms of paralytic talipes. Here also the Z-method may be used with the difference that the divided two halves instead of being used to lengthen the structures are shortened by cutting away the redundancy and then suturing as shown in Figs. 999-1000.

TENORRHAPHY (TENDON SUTURE)

This may be either primary (recent injury) or secondary (injuries of long standing). Union of divided tendons is usually accomplished by

(a) End-to-end union.
(b) Side-to-side union.
(c) Lateral implantation.

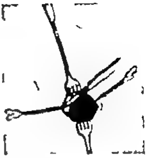


Fig. 992 Fig. 993

Fig. 992. Torticollis, subcutaneous tenotomy. Semicircular b... illustration indicating the incision through which tenotome... introduced to divide adhesions... tendon.
Fig. 993. Torticollis, open operation. Illustration showing division of tendinous (sternal) and muscular (clavicular) portions of the muscle, over grooved director.

Fig. 996 Fig. 997

Fig. 996. Tendon lengthening by the Z method.
Fig. 997. Lengthening of tendon (... the method) above the incisions, below, effect of ... on the tendon. The ... show ... direction.

End-to-end union is the most commonly used. It is the method of choice.

Step. Sterilize the wound.

Step. Incise the tegument sufficiently to allow ample access to the tendon (Fig. 994). If the proximal end of the tendon has retracted, make ample incision to thoroughly expose. The palm offers many difficulties. Exten-

sion of the hand renders these difficulties greater. Action and squeezing the muscles of the forearm down and flexing of the wrist are of great aid. In subcutaneous ruptures of the tendon, exposure by incision should be practiced. Incisions for the exposure of muscles and tendons should be parallel to their course. Make the skin incision slightly to the side of given tendon. Tendon sheaths should also be opened laterally.

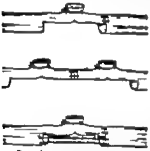


Fig. 998. Above, tendon lengthening by ... below, ... of ... tendon ... suture.

Step 3. Identify the tendons, grasp each end with non-crushing forceps (Allis). Devitalized, crushed tissues should be trimmed away.

Step 4. Materials for suturing the divided tendons are: round intestinal needles, catgut, silk or Pagenstecher linen. It is not essential to penetrate the entire tendon. On the contrary, such sutures may cut through. Lateral sutures properly placed serve the purpose best. Two vertical lateral sutures are the simplest method of tendon approximation. Mattress sutures, reinforced by circular sutures act well. Kirschner method of tendon suture effective.

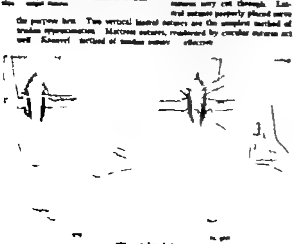


Fig. 999. Tendon shortening.
Fig. 1000. Tendon shortening completed.

Step 5. Close the wound. Relax the sutured tendons by position. Avoid pull on the suture line.

PRIMARY SUTURE OF TENDON SUTURE

This is performed as follows: Thread fine silk suture on both ends of fine round needles. Begin the suture few centimeters from the divided end of tendon, running continuous suture line at the margin of the tendon to its end. here the needle emerges at the cut end of the tendon. the other end of the suture is carried along the parallel margin of the tendon (Fig. 1001). Pass both needles through the cut end of the distal part of the tendon and continue the suture in an inverse direction. Pull both ends together and tie the knot securely. Reinforce the line of suture with interrupted sutures of fine silk or linen.

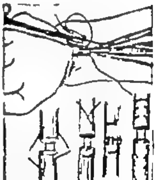


Fig. 1001. Tendon suture. Above, suturing of extensor tendon of the forearm; below, different types of tendon suture (after Kirschner).

Secondary Tendon Suture

This presents greater difficulties than primary suture. The problems present are

To find the divided ends.
To overcome the shortening.

Step 1. Expose the parts with semicircular incision. Dissect up flap.

Step 2. Trace the muscular fibers to the injured tendon. Dissect it free. If sheath encircles the injured tendon, open it laterally; thence trace the tendon to its divided end.

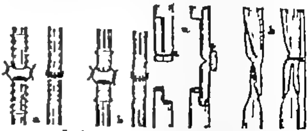


Fig. 1002 Fig. 1003

Fig. 1002. ... method of tendon suture; b, simple tendon approximation.
Fig. 1003. Method of suture and lengthening tendon.

Step 3. Freshen the edges, if need be. If they cannot be approximated without tension, do Z-lengthening operation (Fig. 996). Join the divided ends. Restore the tendon sheath.

Step 4. If possible cover and protect the tendon approximation site with a thin fat reflection or transplant (Fig. 964).

Step 5. Unite the superimposed structures. Dress in position avoiding tension on the sutures. If this is not observed, the sutures will cut out.

FIG. 964. Fat transplant about site of tendon or nerve approximation (after Kirk and Mason)

TENOPLASTY—TENDON IMPLANTATION—TENDON TRANSPLANTATION

This operation is mainly used in paralytic affections (infantile paralysis). In principle the operation consists of detaching certain tendons from its attachment at one point and its transference and implantation at another point (bone, tendon, fascia). Each case requires special treatment. After thorough study of given case tendon implantation is usually performed by tunneling the healthy tendon and pulling through it the divided end of the paralyzed tendon and suturing it in place (Fig. 965) or insert healthy tendon into periosteum at site of insertion of affected tendon.

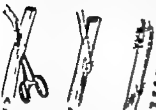


FIG. 965. Tendon transplantation (Robert Jones). A, an opening [illegible] through the healthy tendon and through the [illegible] paralyzed tendon [illegible] drawn and fixed to [illegible] [illegible] C, [illegible] [illegible] tendon, then suturing tendon [illegible].

Tendon transplantation signifies that tendon has been totally detached from its insertion, transferred and fixed by sutures to another (paralyzed tendon) or sutured to bone, etc. Free transplantation of tendon may also prove successful. The tendon used is usually taken from the tendo Achillis.

Tendon transplantation is indicated:

1. Where it is desired to strengthen group of muscles which have become weakened.
2. In conditions where it has become necessary to replace muscle or group of muscles which have become paralyzed.
3. Where balance, obstruction or opposing force is needed to counteract an overactive spastic group of muscles.
4. Where perversion of function makes it necessary to influence the tendon action, for example, changing the tendo Achillis to the outer side of the os calcis in congenital club-foot so that the ankle will not be inverted.
5. In cases of partial arthrodesis.

According to H. O. Thomas, a muscle may seem paralyzed while only overstretched and consequently weakened, as in wrist-drop. In this condition the weakened extensor muscles may have completely recovered from their original incapacity but have been stretched and ruled so completely by the flexor group that they will not act, while the flexors on account of no opposition have become contracted. Recovery may be effected by bringing the hand into position of overcorrection and keeping it that way continuously for several months.

The secondary paralysis is an important point to recognize when surgical intervention is being considered. A newly transferred tendon is not strong and its point of union in its new location consists of weak scar tissue. Consequently undue strain is likely to overstretch it, rendering it useless. The newly transplanted muscle should be treated the same as wrist-drop; the treatment should be continued, according to Jones, until "the patient is able by voluntary effort to make it forcibly act and it can successfully withstand the action of gravity."

Tendon transplantation is indicated in cases of muscular insufficiency which does not respond to other treatment. This insufficiency may be due to partial or complete paralysis of one or group of muscles or lack of balance between muscles functioning on certain joint, that is, one muscle or group being stronger than another. Transplantation strives to restore balance by transplanting power from the strong to the weak. So that this may be successful, it is necessary that enough strong muscles are within reach of the weaker ones. For instance, it would be useless to transplant tendon in condition of flail joint; the loss of power covers too large an area. Transplantation may restore function where the tendon has been lost through accident or disease and direct union is impossible. Always be sure that surgery is indicated, never operate earlier than seven or eight months after paralysis has taken place. Transplantation is used to overcome deformities as well as to restore lost function to muscles.

Partial paralysis about the ankle, characterized by talipes calcaneus, paralytic varus and equinovarus and flexion are the most common lesions calling for operation. The unbalanced muscular condition in spastic paralysis may be caused by an increase of power in one muscle group and may or may not be accompanied by a diminishing power in the opposing group. Transplantation may also relieve contractures caused by inflammatory arthritis.

The operation should be well-planned beforehand. The muscles which have partially or completely lost their function should be definitely known as well as the source of power available to assist them. In adults this knowledge is gained by observing their voluntary movements. In the case of children they are studied while at play.

Any existing deformity should be corrected before transplantation is done, so as to insure the proper balance and transmission of power. Transplantation should not be attempted until the parts have completely recovered from the corrective operation. In cases where the deformity cannot be completely corrected on account of tendon contracture Vulpius combines tenotomy and tendon splicing [illegible] the time of transplantation.

This operation is thought to be overdone by some authors, especially in paralytic flexion of the knee where hyperextension is easily brought about. The gracilis, semitendinosus, sartorius and tensor vaginae femoris may be useful in helping the quadriceps but this assistance is not enough.

Technic. Three fundamental rules must be observed in all cases of tendon transplantation.

First. Joint pathology of any nature must be corrected before tendon transplantation is undertaken.

Second. The tendon to be transplanted must spring from as nearly normal muscle as can be obtained.

Third. The tendon to be transplanted must reach its destination of insertion in straight line and pass through subcutaneous fat or tendon sheath and be inserted directly into bone.

Expose the tendons by means of longitudinal incisions made so that they may be moved over the entire exposed area. The incision should be made to one side of the tendon, not over it. V-shaped incision requires large amount of skin dissection and often cause troublesome adhesions to form.

FIG. 966. Method of splitting tendon and muscle for utilization in tendon transplantation.

If the tendon from which the power is being transmitted is long distance from the tendon on the receiving end second incision is made and the tendon is passed from one aperture to the other through tunnel made with forceps. Close to healthy dark-red muscle is seen perhaps yellowish-white muscle which is very hard to distinguish from the surrounding fat and which is completely paralyzed. Another muscle which has atrophied from disuse may present lighter red shade in [illegible] muscle, paralysis and atrophy may be mistaken as streaks.

A long incision may be necessary to expose the tendon from which the power is being transmitted especially if it is deemed necessary to shape two muscles out of one. In such an instance the split or incision should be continued well up into the belly of the muscle. This is accomplished by blunt dissection, care being taken that the muscle attached to the respective tendon segment is definitely identified. Thus two muscles are formed out of one (Fig. 966). The route by which the [illegible] is transmitted should be as straight as possible. For instance, when [illegible] of leg is used to transmit power to an extensor, it may be transmitted through the interosseous membrane.

R. Jones advocates transplanting the tendon sheath along with the tendon for

lubrication purposes and also to prevent adhesion formations to contiguous structures.

It is unnecessary to incise the fascia for the whole length of the wound when exposing tendons through long skin incisions; it is preferable to interrupt the incision at places, thus facilitating satisfactory closure.

Uniting Transplanted Tendons. Transplanted tendons are united in much the same way as divided tendons. The usual methods of transplantation are depicted in Figs. 966-967 and 968. The surfaces should be washed and the receiving tendon made tense before sutures are applied.

Both the healthy and affected tendons are divided and the peripheral part of the healthy tendon is discarded, thus doing away with the natural function of the tendon. This is recommended only when the natural function of the healthy tendon is undesirable or if it is unimportant.

R. Jones believes the two tendons should be united as near the insertion of the paralyzed tendon as possible to preclude the possibility of stretching. He recommends placing the healthy tendon into suitable place in the periosteum instead of the tendon of the paralyzed muscle.

Artificial tendons of silk are used by Lange in his transplantations. Fascia lata may also be used.

When healthy tendon is too short and where the usual methods of implantation are contraindicated, indirect transplantation may be required.

FIG. 967. Tendon transplantation for [illegible] [illegible] A, tibialis anticus. E, C, extensor [illegible] [illegible] digitorum.

The tendon sheaths are sutured with very fine catgut. Buried sutures are used to unite the deep fascia. After closing the skin, dress and apply firm retentive bandages.

Besides splints, etc. there are many ways by which the transplanted tendon is protected from over-stretching until it becomes functionally competent. Biesalski recommended shortening the paralyzed tendon, thus maintaining the limb in an overcorrected position. Dividing or lengthening the tendons which stretch the newly transplanted tendon is commendable practice.

Aftertreatment. Following operation, the limb should be immobilized for six to eight weeks. If adhesion formation threatens the cast period should be shortened. The patient should remain in bed for four weeks. After union has taken place, some well-regulated form of physiotherapy is indicated. Passive movements and gymnastic exercises are started as soon as feasible. After the patient begins to walk, he should be supplied with some form of mechanical support or boot.

Tendon Transplantation for Talipes Equinus Due to Infantile Paralysis

The only muscles involved in this condition are the tibialis anticus and the extensor communis digitorum. The extensor proprius hallucis and the peroneal

muscles may be used to transmit power to the muscles which are paralyzed (Fig. [illegible]). It is taken for granted in all operations for talipes equinus that tenotomy or lengthening of the tendon has overcome any shortening of the tendo Achillis.

Method of Transplanting "Slip" from the Peroneus Brevis Tendon to the Extensor Digitorum Tendon

Step 1. Make a skin incision curving in a downward direction beginning about five fingers' breadth above the intermalleolar space, curving the lower end slightly inward. Avoid, if possible, the ends of the musculocutaneous nerve which lie in the subcutaneous tissue in the inferior portion of the wound.

Step 2. Divide the deep fascia for the whole length of the wound close to the tendons of the extensor digitorum and peroneus brevis which are usually discerned through the fascia. Dissect the extensor digitorum from its adjoining structures as shown in Fig. [illegible].

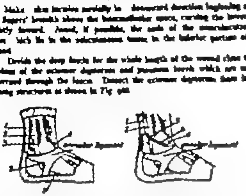


Fig. [illegible]. Tendo Achillis, peroneus longus, peroneus brevis, extensor tendons, slip from tendo Achillis, tendon of peroneus brevis used as graft.

Step 3. Make an incision about 4 inches long beginning a little below the external malleolus, parallel to and slightly behind the fibula. Divide the peroneal sheath and separate the tendon of the peroneus brevis from the surrounding structures.

Step 4. Divide the tendon of the peroneus brevis up as high as possible into an anterior and posterior segment. Sever the anterior segment even with the malleolus. A tendon flap with a superior base results.

Step 5. Form a tunnel connecting the two vertical incisions. Keep the tunnel close to the external side of the fibula which is denuded for 2 or 3 inches. Draw the tendon flap mentioned in Step 4 through this tunnel so that it comes to rest in the front of the leg.

Step 6. While the foot is bent backward in an hyperextended position, draw the extensor communis tendon upward until it is taut and make a longitudinal buttonhole in it. Pull the peroneus brevis flap through the buttonhole from behind forward and suture as much as possible by suture.

Step 7. After carefully controlling all hemorrhage close the wound.

Method of Transplanting "Slip" from the Extensor Proprius Hallucis to the Tibialis Anticus

This operation may be performed independently or it may be supplementary to the procedure described above.

Step 1. (Same as Step 1 in the foregoing.)

Step 2. (Same as Step 2 in the foregoing.)

Step 3. Draw the margin of the incision toward the center. After exposing the extensor proprius hallucis and its tendon, divide the latter into an external and internal segment. Incise the external segment transversely at the lower level of the annular ligament thus obtaining a tendon flap which is fastened to the muscle above.

Step 4. Separate the tendon of the tibialis anticus; retract it upward and bend the foot backward. After making a longitudinal buttonhole in the tibialis anticus tendon, draw the free end of the hallucis tendon flap through it and fasten it as close to the insertion of the extensor tibialis anticus as possible.

Method of Transplanting "Slip" from the Extensor Proprius Hallucis to the Extensor Communis Digitorum—Shortening of the Tibialis Anticus

Step 1. Make an incision in the midline extending downward from a point five fingers' breadth above the intermalleolar space, curving the lower end of the incision inwardly and slightly upward. Incise only the skin, avoiding the ends of the musculocutaneous nerve in the subcutaneous tissue.

Step 2. After dividing the deep fascia, identify and separate the tendon of the extensor proprius hallucis which lies on the inner side of the extensor communis tendon.

Step 3. Divide the tendon of the extensor proprius longitudinally into an external and internal segment. Make a transverse incision in the outer segment even with the inferior border of the annular ligament.

Step 4. While strongly extending the foot, draw the extensor communis digitorum upward. After making a longitudinal buttonhole in this tendon, draw through it the flap made from the extensor proprius. This is firmly sutured.

Step 5. Draw back the internal margin of the wound, exposing the tendon of the tibialis anticus and make it shorter the same as the tendo Achillis as shown in Figs. [illegible] and [illegible] on p. [illegible].

Comment. Subsequent to the above operations, Robert Jones believes the removing of skin flaps is of aid in keeping the tendons free from tension. He states: "Personally I see that the deformity of the foot is over-corrected before any operation is performed; and as soon as the tendon is transplanted, as in arthrodesis, I remove an oval skin flap from the paralyzed side so large that when the edges are sewn together the foot remains fixed in an overcorrected position. The removal of the skin flap, I venture to suggest, gives us considerable help in removing strain from the transplanted tendon. The foot by this means, as I have said before, remains in the desired position in spite of any outside influences."

Royal Whitman comments as follows with reference to tendon transplantation in paralysis of club-foot:

"Tendon transplantation is most effective from the curative standpoint when but one muscle of the anterior leg group, for example an adductor or abductor, is paralyzed. The most common form of this milder type is paralysis of the tibialis anticus. As this muscle is the most powerful dorsal flexor and adductor of the foot its loss is followed by secondary equinovalgus. In Parish's operation the tendon of the adjoining extensor proprius

pollicis was simply attached to that of the tibialis anticus, but as the extensor of the great toe is a very weak muscle, its power is hardly sufficient for the double task. A more efficient procedure is to split the tendon of the paralyzed muscle. The outer half is then separated from its muscular attachment, and the distal extremity is carried laterally across the foot and is sutured to all the other tendons. The proprius pollicis is then attached to the inner half. In cases of longer standing and more marked deformity it is well to reduce the power of the abductors by cutting the tendon of the peroneus tertius from its insertion. This is then drawn beneath the other tendons and is attached to that of the tibialis anticus. All of the tendons on the front of the ankle may thus be sutured to one another so that all may act as direct dorsal flexors.

The relative strength of the muscles, as well as their functions, should be considered in selecting grafts, and in prognosis also. According to Fick, it is as follows, in kilogrammeters:

Back of the Leg

The calf muscles—gastrocnemius and soleus	[illegible]
Tibialis posticus	[illegible]
Peroneus longus	0.44
Flexor com. digitorum	[illegible]
Flexor longus pollicis	[illegible]
	[illegible]

Front of the Leg

Tibialis anticus	[illegible]
Extensor proprius pollicis	0.39
Extensor longus digitorum	[illegible]
Peroneus brevis	[illegible]
Peroneus tertius	[illegible]
	[illegible]

"The importance of the calf muscle on the back, and tibialis anticus on the front of the leg is apparent. The former is nearly four times as strong as the combined posterior group, the latter equal to all the others on the front of the leg. It has been claimed that the transplanted muscle may become hypertrophied, and that its strength may increase sufficiently to carry out its new function, but this is somewhat doubtful.

When the calf muscles have become paralyzed and talipes calcaneus has ensued, and if the muscles are not in a hopeless condition, the applying of Thomas' principles combined with an immobilization of the leg with the foot in a plantar flexion position over a protracted period may give encouraging results. It should be tried before operation is resorted to. Some authors advise shortening of the tendon. However, it would seem better to furnish new power to the tendon.

Method of Transferring Tendon Flap from the Flexor Longus Digitorum to the Tendo Achillis

Step 1. Make a 4 inch incision in the midline between the tendo Achillis and the posterior margin of the tibia beginning about 1 inch below the tip of the internal malleolus; extend the incision upward (Fig. [illegible]).

Step 2. Divide the tendo Achillis so as to form a flap of tendon about [illegible] inches long which is fastened to the os calcis below leaving the upper end free.

Step 3. Make an incision in the deep fascia parallel to and close to the back margin of the tibia. Be careful not to injure the tibialis posticus sheath and the muscle belly of the flexor digitorum as well as those between it and the flexor proprius hallucis. Detach the tendon of the flexor longus digitorum opposite the internal malleolus after exposing it.

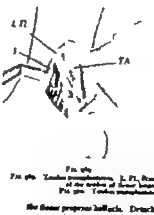


Fig. [illegible]

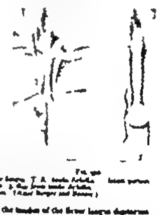


Fig. [illegible]

Fig. [illegible]. Tendon transplantation. L.D., flexor longus; T.A., tendo Achillis; [illegible] lower portion of the tendon of flexor longus; [illegible] flap from tendo Achillis.
Fig. [illegible]. Tendon transplantation. (After Berger and Banzet.)

Step 4. Make a longitudinal incision in the tendon of the flexor longus digitorum so as to form an anterior and posterior segment. Make a transverse incision in the posterior segment forming a flap with a pedicle above.

Step 5. Place the ankle in a plantar flexion position, laying the tendo Achillis flap and the flexor longus digitorum flap alongside each other and suture them together.

Step 6. Make the latter part of the tendo Achillis shorter.

Step 7. Close the edges of the wound; apply dressings, immobilize the ankle in a plantar flexed position.

Method of Transferring Tendon Flap from the Peroneus Longus to the Tendo Achillis

Step 1. Make a [illegible]-inch incision in the midline between the fibula and the tendo Achillis beginning 1 inch below the external malleolus and extending upward.

Step 2. After exposing the external margin of the tendo Achillis, form flap about ½ inches long with its pedicle attached to the os calcis below.

Step 3. Make deep fascial incision parallel to and close to the posterior border of the fibula. Expose and incise the sheath of the peroneal muscles. Find the tendon of the peroneus longus lateral to the peroneus brevis tendon (Fig. 970).

Step 4. Form an internal and external segment by dividing the peroneus longus tendon. The external segment is left intact while the internal segment is incised transversely close to the malleolus forming flap with its base above.

Step 5. Maintain the foot in position of equinus. Place the flaps which have been formed alongside each other and suture them together.

Fig. 971. Tendon transplantation. (After Lahey.)

Step 6. Make the intact part of the tendo Achillis shorter.

Step 7. Close the edges of the incision with sutures. Apply dressings. Immobilize the ankle in position of equinus.

Method of Transferring Slips from the Tibialis Posticus and Peroneus Longus to the Paralyzed Tendo Achillis (Lahey)

Step 1. On the back of the leg, make forked incision as is depicted in Fig. 971. Turn back the flaps which are identified as ABC, ABD, CBD. Pull back and save the external saphenous vein and nerve external to the tendo Achillis.

Step 2. Divide the fascia, exposing the external border of the tendo Achillis. Incise the peroneal sheath.

Step 3. Make an incision in the tendon of the peroneus longus forming an anterior and posterior segment. Insert the peroneus muscle fibers into the tendon, further incision, increasing the upward incision of the tendon and forming two muscular bellies; each belly is attached to slip made of half of the tendon. Be careful so as not to injure the nerves entering the muscle. Make transverse incision in the posterior slip of the peroneus tendon as far down as possible (Fig. 972 and b).

Step 4. Incise the outer side of the tendo Achillis longitudinally. Draw back the edges of the incision forming furrow. Place the mobilized posterior segment of peroneus tendon into the furrow and suture it in place. (Fig. 972)

Step 5. Make fascial incision on the internal side of the tendo Achillis. Pull the tendon outward exposing the deep fascia under which the posterior tibial vessels and nerves are visible. Make longitudinal incision in the deep fascia internal to the vessels and nerves; draw these structures back. Expose the tibialis posticus in the deep part of the wound.

Step 6. Separate and divide the tendon of the tibialis posticus. Implant segment into the tendo Achillis identical with the peroneus longus. The

foot is held in a hyperflexed position during all of these manipulations (Fig. 972 c-d.)

Step 7. Close the edges of the wound (Fig. 972). Apply dressings. Immobilize the part and maintain it in position of hyperflexion.

In some procedures the flexor proprius hallucis may be implanted into the tendo Achillis the same as the tibialis posticus; the peroneus brevis is treated the same as the longus.

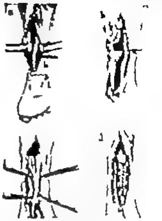


Fig. 972. Tendon transplantation. (After Lahey.)

Method of Transferring Power to the Peroneal by Means of Slip of Tendon Derived from the Tendo Achillis (Lahey)

This procedure is indicated where the extensor communis digitorum, peroneus longus and brevis are paralyzed and the foot takes on the position of varus.

The patient is placed in intermediate position on his sound side. The leg is flexed on the thigh and an assistant holds the foot.

Step 1. Make an incision in the midline between the posterior margin of the external malleolus and the external border of the tendo Achillis beginning inch below point even with the malleolus and extending upward to point even with the middle of the calf. Carefully expose and retract the external saphenous vein and nerve.

Step 2. Expose and liberate the external margin of the tendo Achillis. Expose the muscular belly of the outer head of the gastrocnemius in the upper portion of the incision. Detach it from the soleus, while working from above downward, until point is reached where they are definitely merged and cannot be separated. Plantar flexion of the foot relaxes the tendon.

Step 3. Divide the tendo Achillis with knife (Fig. 973). The tendon slip

from part of the gastrocnemius above is detached from the soleus. Make transverse incision far down on the tendon slip forming at once a flap.

Step 4. Make an incision in the fascia over the peroneal muscles in the anterior three-fourths of the wound. Separate the peroneus longus and the brevis. Draw back the peroneus longus tendon. Insert the muscular fibers of the brevis into flat tendon lying over these fibers. Through longitudinal incision which penetrates half the muscle, draw back the margins of the incision so that the peroneus brevis now forms furrow where the tendon of the longus is placed.

Step 5. Pull the mobilized flap of the tendon Achillis through between the peroneus longus and brevis and fix in place securely with sutures. Twist the tendon flap while placing it so that its back surface which faces, is against the cut surface of the soleus thus preventing the formation of adhesions.

Fig. 973. Tendon transplantation. (After Berger and Banzet.)

Step 6. Close the edges of the wound. Apply dressings. The part is immobilized, in position of plantar flexion and outward rotation.

Method of Repairing Lost Flexor Tendon from the Finger, by Transplantation (Von Hacker)

Step 1. Make skin flap (Fig. 974 a) exposing the entire palmar aspect of the affected finger, in this case the middle finger.

Step 2. Make two incisions (Fig. 974 b) along the line of the extensor communis digitorum over the second metacarpal bone.

Step 3. Divide the tendon through these incisions, making long tendon flap pedicled close to the base of the affected finger. Insert this flap through subcutaneous tunnel to the palmar surface of the middle finger and fasten its end by suture to the periosteum of the ungual phalanx.

Step 4. Place piece of newly removed hernial sac around the transplanted tendon and in the middle of the finger suture piece of fibrous tissue from the destroyed tendon sheath across the tendon.

Step 5. Close the wound. Drain.

GANGLION

A ganglion is benign tumor usually occurring on the wrist or ankle. It is occasionally seen on the hand or elsewhere. Its contents consist of viscid fluid. It is sometimes obliterated by placing it in prominent position and striking the skin over it. The contents are then absorbed. The reparative process is aided by the application of snug bandage (Fig. 975).

The surgical removal of ganglion is often complicated procedure. Gen-

eral anesthesia should be used. Rigid asepsis is paramount, for often the tendon sheath harboring the ganglion is opened during the operation. Apply tourniquet. An attempt should be made to remove the ganglion in toto in one piece. Also, it may frequently be necessary to ablate portion of the tendon sheath.

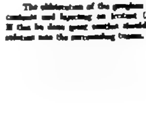


Fig. 974

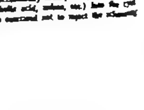


Fig. 975

Fig. 974. Tendon transplantation.
Fig. 975. Ganglion of the wrist.

The obliteration of the ganglion is occasionally attempted by aspirating its contents and injecting an irritant (carbolic acid, iodine, etc.) into the cyst. If this be done great caution should be exercised not to inject the irritating solution into the surrounding tissues.

CHAPTER 23

AMPUTATIONS AND EXARTICULATIONS

The term amputation signifies the removal of a part or of an entire given limb. Removal of a limb or a portion of a limb at a joint is spoken of as disarticulation or exarticulation.

Historical Notes. The ancients and Celsus practised simple transverse division of an extremity. Ligation of vessels in lieu of burning off at the cautery iron was introduced by Ambroise Paré in 1552. Petit in the eighteenth century introduced the tourniquet which made possible the control of hemorrhage and more deliberate procedures.

Fig. 976. Amputation through the thigh.

CLASSIFICATION

As to Time. Primary amputation is performed soon after the occurrence of the accident (as soon as the patient recovers from shock and before symptoms of infection supervene). Secondary amputation is done for removing a useless limb or after infection has supervened.

As to Skin Flaps. (Fig. 976.) Flap amputations, where a flap is formed; flapless amputations, where no flap is fashioned such as the amputations of

(1) Celsus and the
(2) Guillotine amputation.

As to Shape of Flap (Fig. 977)

(1) Circular
(2) Oval or Elliptic
(3) Racket Shaped

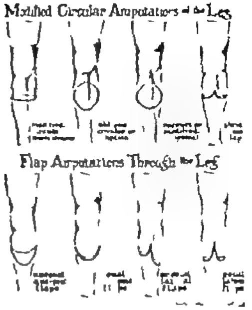


Fig. 977. Lines of incision for modified circular and flap amputations of the leg.

(4) Anteroposterior (equal or unequal length).
(5) Lateral.

As to Periosteum.

(1) Periosteal. Subperiosteal of the periosteum, division of the bone, suture of the periosteum to cover the divided end of the bone. This procedure may be followed by a osteoplastic stump.
(2) Aperiosteal, Bunge's Amputation. Used by most surgeons. This consists of ablation of one or two cm. of periosteum and the ends of the bone are smoothed.

As to Location.

(1) In continuity through the bone
(2) In contiguity disarticulation through the joint

As to Bone. Osteoplastic amputation. When a layer of attached bone covered by periosteum is placed over the divided bone ends so as to form an end bearing stump (Gritti-Stokes, Pirogoff).

Kineplastic or Kineplastic amputations. Introduced by Vanghetti in 1898. The intent here is to direct transmission of voluntary movements from the muscles of the stump to an artificial limb. Artificial points of attachment are made from the muscles of the stump (plastic motors) from which cords transmit movement to the artificial limb. There are three divisions of motors: Clava (club), Loop (ansa) and 3. Tunneled motors through the muscular masses.

G. Rapidi reviewed the results reported in the literature (and a few cases of his own) of kinematic plastics according to the Vanghetti method. He observes that there are difficulties in applying the method (a) because the kinematized individuals do not exercise their muscle stumps, (b) because having undergone one (amputation) experience and generally being in receipt of a pension, they do not care to submit to another operation, and (c) because even with the best methods the alterations in the muscle and other tissues do not always yield a good functional result. It may, of course, be the other way so that a good muscular kinematic stump is not fitted with a very suitable prosthesis. Rapidi is opposed to kinematic plastics in amputated tuberculous limbs. He sees no ultimate advantage and the tuberculous process in the region of the stump reawakened. It is, however, advisable in cases of primary amputations. There are all practical difficulties which limit the application of the method.

It often happens that in these kinematic plastic operations the functional results (as regard the stump) are so good that the mutilated individual gets on very well without the prosthetic appliance. Cases of all of these kinds have been observed and reported.

Rapidi reported a series of experimental kinematic plastic operations (altogether) carried out in dogs. Here after an amputation the formation of a kinematic muscle stump was attempted either without or with a band of periosteum reattached to the sectioned bone.

In all experimental animals he noticed in the muscle tissue a subacute interstitial myositis, more or less accentuated. In the tendon tissue a phlogistic process with connective proliferation; in the nervous ambing had a plat neuroma of connective tissue. These histopathologic and findings which are met in the muscles and tendons of kinematized stumps prove that kinematic plastics cause some noteworthy changes in the tissues and that such changes should be considered in estimating the probability of functional results.

AMPUTATIONS IN GENERAL

Surgical removal of an extremity or of part of it may be indicated for several reasons. The limb may be injured beyond repair (here however it is a matter of surgical judgment) or even "surgical luck," for surgeons who occasionally preserve badly mutilated limbs. It gets a good outcome and even functional result. While another with equal skill and care will not and

sooner or later he will be forced to amputate the affected limb. Severe infection or the presence of an inoperable malignant tumor leaves no alternative to amputation, if the patient can stand the ordeal. In general, it is sound surgical practice to preserve any part of the body if there is any reasonable possibility that the patient's life is not thereby endangered and that at least some functioning of the part will remain. One cannot dogmatize about surgical judgment in such matters as everything depends upon the patient's general condition, the surgeon's experience and type of postoperative care that can be secured in each given case. I have seen limbs crushed and apparently mashed beyond hope restored to almost normal function.

In every important limb amputation there are two main objectives which the surgeon must bear in mind. First, to remove the useless part with as little shock and sacrifice as possible and second, to provide a stump which will not only cause no pain or trouble to the patient but will be most suitable for the application of an artificial limb.

The time of removal will depend upon the nature and urgency of the case. Severe hemorrhage, which cannot be arrested, rapidly spreading infection or severe traumatism with profound shock tasks the judgment of the surgeon to its utmost. While immediate amputation is usually a pressing surgical emergency, the removal of a limb, such is the case of malignant growth or other incurable condition, may be a matter for more deliberation and planning, in which a certain type of removal or stump formation may be executed.

The method of amputation will almost entirely depend upon the question of immediate necessity or postponed removal. There are several methods differing in their technic so as to provide different types of stumps. If the amputation is one of immediate necessity and the patient is in poor general condition one of the most rapidly executed methods must be selected and of these that which is known as the

Guillotine amputation which frequently (Fig. 976 b) is probably the best and is very often carried out, especially in military surgery. It was much used during the recent World War. In this method the limb is cut clearly through with a circular sweep of a large amputating knife so that no muscle flaps are provided, as the same time the bone is sawed through at the same level. A tourniquet should be used or preliminary ligation resorted to. In certain cases this operation is intended as a temporary measure only and a secondary or postponed amputation will usually follow later if the patient survives. Although surgically such method is open to some objections, there is often no choice as frequently the occasion is a matter of life or death. In civilian surgery there may frequently be time to fashion some large muscular flaps which can be drawn together quickly sutured, and ample drainage provided.

In postponed amputations the

Circular method (Figs. 976-977-978) was formerly much used, the

(1) Skin and subcutaneous tissues being divided around the whole circumference of the limb by a circular sweep of the amputating knife. These are then retracted or dissected back like a cuff and the underlying structures divided in similar manner.

(2) The soft parts are again further retracted and the deeper m

In selected cases of ... Ann ...

divided; this allows clearing of the bone and sawing it through at a higher level than the original circular incision

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Step [illegible] Technic of carrying the amputating knife in circular amputation of the arm

Fig. [illegible] Step [illegible] Technic of carrying the amputating knife in amputation of the arm.

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Step 3. Position of the knife in final division of the [illegible] at circular amputation of the arm.

Fig. [illegible] Final step. Position of the amputating knife.

(3) The end of the bone which is in the center of a conical hollow is then covered

(4) The blood vessels must be carefully ligated before removing the tourni-

quet The stump, particularly in the lower extremities, except when fashioned with very extreme care, is not usually very shapely and after some time, owing to the shrinkage of the soft parts, the scar is likely to become attached to the bone

Fig. [illegible] Types of flaps for various amputations and disarticulations. [illegible]

The Elliptical or Oval method is a modification of the circular method (Fig. 977) Here the incision around the limb is oval, the lower or distal portion of the flap is then dissected up so as to enable the amputation to be completed at a level a little below the proximal end of the oval incision. The free convex

border of the flap is then turned over and fitted into the concavity of the wound.

Another modification of the circular method is called the

Racket Method (Fig. 977) which is more usually practiced in amputation at lower points of the extremities and for the shoulder and hip. In it, an oval incision is made around the limb with one end pointed which, if necessary, is prolonged upward to form the handle of the so-called racket.

The Flap method of amputation is now in almost general use. The flap is made to include the skin, subcutaneous tissue, deep fascia and perhaps some muscle (Fig. 977)

Especially for the lower (weight-bearing) extremity in and about the knee-joint, to provide a comfortable adaptable stump, the

Gritti-Stokes method (Figs. [illegible]) of flap amputation is much employed. In executing this amputation a long anterior and short posterior flap

A B

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Incisions for Gritti-Stokes amputation.

Fig. [illegible] Supracondyloid osteoplastic amputation of the femur (Gritti-Stokes)

is made. The amputation is done at the knee-joint where the incisions are made across the tubercle of the tibia. The patellar tendon is severed at its insertion on the tibia and preserved for future use. The anterior flap includes the patella and all other tissues down to the joint. The posterior flap is short and is not dissected up more than [illegible] or 3 cm. The hamstring muscles are divided just above their insertions and later sutured to the patellar ligament. The patella is turned back and its articular surface sawed off; all synovial membrane is removed. The femur is divided just above the condyles at a point where the cut end of the bone will be approximately the same size as the cut surface of the patella, which is then sutured into apposition.

The nerves are shortened and injected with 95% alcohol. Excessive fat and muscle tissue are removed. The patella is sutured snugly to the cut end of the femur by interrupted chromic catgut sutures through the fascia surrounding the bone. The gracilis, sartorius, semitendinosus and semimembranosus

muscles, with the biceps on the opposite side, are fashioned to the proper length and sutured snugly to the patellar tendon; this gives them a new insertion and balances the pull of the quadriceps muscles.

There are other methods of amputation of the lower limb aiming at the formation of a desirable stump, such as for instance the Fournier-Jordan procedure for the hip joint.

In summarizing what has been said about amputations generally, it is again stressed that sufficient soft tissues must be preserved wherever possible to cover the cut end of the bone. The skin flaps should not be too long and should be protected from gangrene by proper blood supply. It is good practice to drain an amputation stump from its most dependent point for 24 to 48 hours.

Amputation stumps are liable to special pathologic conditions. These are: (a) pain and tenderness which usually persist for some months; (b) wasting or atrophy of the severed muscles which continues until the stump becomes what is termed "consolidated"; (c) infection of the stump which may be present at the time of operation or occur after it, giving rise, sometimes, to sinuses and sequestra; (d) a persistently painful stump is usually the result of infection, neuritis or of the adherent neuro-fibroma (amputation neuroma) (this type of continued pain may be either localized or diffuse; special treatment or even reamputation may be necessary); (e) conical stump results when the soft tissue flaps have been inadequate to cover the bone properly; (f) adherent and unsound scars usually result from inadequate or improperly placed flaps; (g) sloughing of the flaps and necrosis of the end of the bone stump occasionally occur and are due to infection; and finally (h) contractures of the muscles around the joint above the amputation is not uncommon and is usually due to spasm following irritation and infection of the stump or a deformity following the bandaging of muscles in a bad position.

In doing an amputation the surgeon must always bear in mind the wearing by the patient of an artificial limb or other prosthesis. Stumps looked at in the light of prosthetic value are of two types: (a) those which may be expected to carry the weight of the body and (b) those which are expected to continue only the motor function of the removed limb.

In the lower extremity the artificial limb is usually secured by lateral pressure against the bony prominences such as the tuberosities of the tibia, and walking is greatly improved if the patient can bear his weight on the end of the stump.

In the upper extremity weight-bearing scarcely enters into consideration. Here it is function that counts and in doing an amputation, abduction of the upper part of the arm must, as far as possible, be guarded against. The joint above the amputation must also be kept movable and not allowed to become stiff. For these reasons it is often necessary and desirable to apply a splint to keep the muscles quiet and prevent undesirable contractures. In an amputation of the forearm the elbow is likely to be overlooked and fixed and extension may be seriously interfered with or lost if a splint is not applied. The same remark applies to an amputation below the knee.

No artificial limb or appliance should be applied until sufficient time has elapsed to allow the tissues and structures involved in the amputation to become quite consolidated and shrunken to their full extent. Several months may be

necessary for this, although, of course during part of this time temporary apparatus may be worn which will help the patient and the convalescence by active movements, apart from the generally improved mental state in moving about and learning to walk without crutches.

AMPUTATIONS IN THE UPPER EXTREMITY

CIRCULAR AMPUTATION

The circular method of amputation is the basis of all methods of ablating limbs. Amputation of the arm will be described as an example.

Anatomic Points. Retraction of the muscles after section in the upper half is unequal. In the lower half they retract equally (Fig. [illegible]). In order to pre-

FIG. [illegible]. Amputation about the middle of the forearm. (From Deaver, Applied Anatomy.)

serve the usefulness of an upper arm stump, knowledge of the insertions and nerve supply of the deltoid, pectoralis major and latissimus dorsi is essential.

Step 1. Block anesthesia of the brachial plexus may be used in amputation of the upper extremity. The procedure is depicted in Figs. [illegible]. The patient is placed recumbent with the arm abducted. Apply a tourniquet near the shoulder. Grasp the arm above the proposed line of incision pulling the skin forcibly upward (Fig. [illegible]). Note the point at which you propose to divide the bone and then make a circular incision (illustration shows unequal anteroposterior flaps) through the skin down to the deep fascia at a distance below this point equal to three fourths of the anteroposterior diameter of the limb. The skin and superficial fascia are reflected upward for a distance of from one to one and a half inches. The remaining soft parts are divided to the bone (Fig. [illegible] b).

Step 2. A circular incision is now made through the periosteum at the level of the division of the muscles which together with the periosteum are pushed

back with a rugine for about an inch or so. At this level the bone is to be divided. Retract the soft parts with a double-tailed retractor. Divide the humerus with a saw (Fig. [illegible] b).

Step 3. Ligate the brachial artery and any of its visible branches before the tourniquet is removed. Identify the median, ulnar and musculospiral nerves. Inject them with alcohol (95%) and cut off an inch or so of each. Remove the tourniquet. Grasp any bleeding vessels and ligate them. Hot compresses will arrest oozing (Fig. [illegible]).

Step 4. Obliterate all dead spaces with properly placed catgut sutures (Fig. [illegible] d). Close the stump by suturing its edges, converting the circular into a transverse wound. If deemed advisable (dead spaces, doubtful asepsis, incomplete hemostasis) provide drainage for a day or two with a tube or cigarette drain.

[illegible] Anesthesia of the brachial plexus. Note the position of the subclavian artery and the cords of the brachial plexus in the neck and immediately below the clavicle.

Comment. Where, because of the conical shape of a limb, it is difficult to retract the tissues upward sufficiently through a circular incision, the

FIG. [illegible] FIG. [illegible]

[illegible] Block anesthesia of the brachial plexus by subclavicular approach showing the point of introduction of the needle under the clavicle.

[illegible] Block anesthesia of the brachial plexus, supraclavicular approach. The needle is introduced above the clavicle as shown at the black point above. The points below the clavicle are for purposes of orientation.

difficulty may be promptly overcome by making lateral incisions through the soft structures. A racket incision is thus produced and the amputation

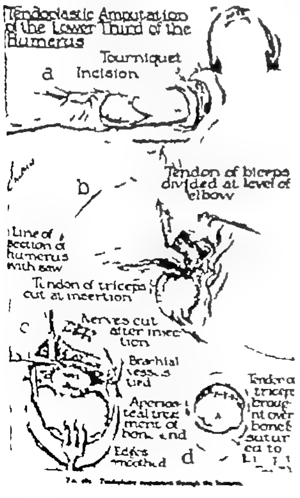


FIG. [illegible]. Tendoplastic amputation through the humerus.

performed by two equal flaps or the oblique circular method of Kocher may be used. Fig. [illegible] illustrates the steps of the tendoplastic method of amputation of the lower third of the humerus and suturing the triceps to the biceps tendon.

DISARTICULATION OF THE SHOULDER JOINT

Historical Notes. T. Morand is ascribed the first regular disarticulation of the shoulder joint in [illegible]. In [illegible] LeDran the elder used an axillary flap. A posterior flap was used by Sharp in 1740 for disarticulation. Dupuytren is given credit for having developed the deltoid (external) flap. Pamard ([illegible]), Goodman ([illegible]) and Charles Bell ([illegible]) have contributed to the development of the operation. [illegible] in [illegible] used a long deltoid and a short internal flap. Guthrie in the early part of the nineteenth century employed the oval method, however used the oval method in [illegible]. In [illegible] Larrey used the external racket and Spence, the anterior racket incision. Larrey during the Napoleonic wars in one hundred disarticulations of the shoulder joint lost only ten patients. Quite a record in those days.

Control of Hemorrhage During Shoulder-Joint Disarticulation

Ligation of the Vessels. This is the simplest and most effective method. The axillary vessels are ligated under the coracobrachialis muscle. The subclavian artery may first be exposed and a temporary clamp applied. In large vascular tumors about the head of the humerus the subclavian artery may be ligated as a preliminary measure.

Digital Compression of the Subclavian Artery is unsatisfactory, because the movements of the shoulder during the operative manipulations will interfere with successful compression.

3. Control of Hemorrhage by Elastic Constrictors. The constrictor is made to surround the shoulder, back of the acromial and coracoid processes and there secured. However the constrictor may slip. To obviate this, the loop of a bandage may be passed under the constrictor and the constrictor pulled toward the opposite shoulder. The tubing of the constrictor may be applied with a double turn around the shoulder and fastened by a figure of eight across the chest or under the axilla. Wyeth's pins method may also be used to prevent slipping of the constrictor. These methods are not recommended because with the Wyeth pins or figure eight elastic constriction violent hemorrhage may occur as the bone is removed. It is well to remember that when amputating for malignant disease it is better to sacrifice too much in preference to too little and if during the operation a great deal of tissue has been sacrificed, flaps can subsequently be taken from the chest to cover the defect.

Spence Operation or Racket Method

Step 1. The arm is slightly abducted and rotated outward. An incision is made from a point just external to the coracoid process down through the clavicular fibers of the deltoid and pectoralis major muscles, the humeral attachment of which is divided (Fig. [illegible]). The incision is now curved outward and backward as far as the posterior border of the axilla. The incision practically at the base dividing the lower part of the deltoid.

Step 2. A similar incision is made around the inner (axillary) side of [illegible]. Here only the skin and superficial fascia should be divided. The cream does not reach as low down as the outer one.

Step 3. The outer flap is now separated from the bone and joint

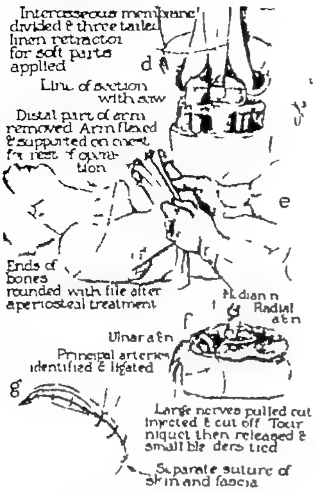


Fig. 998. Amputation through the forearm. (Continued.)

incision. Make a long semilunar palmar flap consisting of skin and deep fascia. Before removing the tourniquet, the radial and ulnar arteries are ligated. Leave the median nerve and treat it as outlined before (alcohol injection, high division). Amputations through the wrist are to be avoided according to Thomas & Orr, as a matter of choice, because as Orr says, "An artificial hand fitted to an amputation through the carpal bones projects beyond the length of the normal hand and is unsightly and awkward. Best fitting can be obtained with an amputation at the junction of the middle with the lower third. Joint amputations are to be avoided because they produce bulbous stumps that are difficult to fit."

AMPUTATION THROUGH THE FOREARM

Choose the method which yields the longest stump. Because of the conical shape of the stump an artificial limb cannot be adjusted to the forearm alone, but must also receive support from the elbow. Aim for as great length of bone as possible. Preserve whenever possible the movements of flexion, extension, partial pronation and supination by respecting the insertion of the brachialis anticus, biceps, anconeus, triceps and pronator radii teres (Fig. 998).

The transverse circular method is best suited for amputations through the lower third of the forearm while equal antero-posterior flaps will serve best in amputations in the upper two-thirds. The illustrations depict the steps of the operation.

DISARTICULATION OF THE ELBOW

Historical Notes. Ambroise Paré is credited with having first performed the operation in 1536. Jordan in 1848 performed the operation by the external flap method (Coeur method). The anterior flap method was developed by Brasdor, Larrey and Dupuytren. Velpeau used the circular method.

Anatomic Considerations (Fig. 999). The head of the radius is the guide to the joint. It can always be felt at the postero-lateral aspect of the elbow. The joint line about a finger's breadth below the anterior crease of the elbow. Disarticulation through the elbow joint produces an undesirable, bulbous stump.

This may be done by the (a) elliptical method or (b) by a long anterior and short posterior flap.

Circular Incision

Step 1. Make a circular incision through the skin and superficial fascia about two inches below the condyles of the humerus. Reflect the skin upward. Expose the joint.

Step 2. Extend the joint forcibly. Enter the joint through a transverse incision carried in front of the joint. Sever the lateral ligaments.

Step 3. *Further extend the joint. Cause the olecranon process to project into the wound.* Divide the tendon of the triceps at the tip of the olecranon process. Hemostasis. Closure of the wound.

Kocher Operation

Step 1. Flex the forearm to an angle of 135 degrees.

Step 2. Begin with an oblique incision anteriorly over the joint line and terminate it posteriorly a hand's breadth below the summit of the olecranon process (Fig. 1000). Kocher criticizes this incision by stating "the soft tissues of the anterior surface contract very markedly, those of the posterior not at

all or very little, so that a circular incision at the elbow will become by the contraction of the tissues an oval one with a long posterior flap. It is necessary to bear this fact in mind so that the posterior flap may be made sufficiently long."

3. Form a posterior flap comprising the integument, the insertion of the

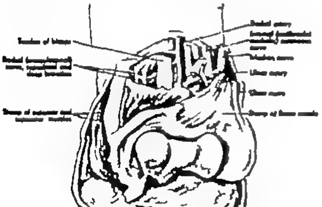


Fig. 999. Amputation at the elbow joint. (From Davis' Applied Anatomy.)

Fig. 1000. Disarticulation of the elbow joint by the oblique circular method of Kocher.

triceps muscle, the anconeus and the periosteum. These are dissected upward until the posterior surface of the humerus is reached.

Step 4. Open the joint anteriorly by a transverse incision; expose the radiohumeral articulation from without inward (Kocher). Remove the limb.

Step 5. Hemostasis. Close the wound.

AMPUTATIONS IN THE LOWER EXTREMITY

AMPUTATIONS OF THE FOOT AND TOES

Disarticulation at the metatarsophalangeal joint is preferable to a partial amputation. The short stump left in partial amputation often makes troublesome appendages.

Amputation of the Great Toe

This operation as performed corresponds to an analogous procedure on the fingers. It is best performed by a single plantar flap. Flex the toe holding it between the left thumb and forefinger. Locate the interphalangeal joint. Open into it by a transverse incision at right angles to the surface. Divide the lateral ligaments. After these and the glenoid ligaments are divided, turn the blade of the knife toward the tip of the toe, hugging the plantar surface of the phalanx. There should result a square-shaped flap. Unite the ends of the opposing surfaces. Close the wound. The scar will be above the head of the bone.

Disarticulation at the Metatarso-Phalangeal Joint

There are several methods for this procedure. Farabeuf's operation, while not the easiest, is considered by most surgeons as the best.

Farabeuf's Disarticulation (Latero-plantar Flap Method)

Locate the joint line. Mark out the incision (Fig. 1001). Grasp the *lateral* toe between the forefinger and thumb. Make a slightly curved incision down the toe until the neck of the phalanx is reached, pushing the incision over the inner side until the plantar surface is reached. Dissect the skin flap away from the second toe, from the points of the incision. Cut down directly to the bone; divide the extensor tendon below the level of the joint. Dissect back the internal flap to the joint line. Detach the glenoid ligament from the base of the phalanx. Divide the lateral ligaments to complete the disarticulation. Hemostasis. Suture the flap into place.

Comment. It is important to remember that the incision should not be commenced above the joint line. If this be not observed the head of the metatarsal bone will prevent the flaps from proper approximation. This will necessitate the removal of a portion of the articular surface. This is to be avoided, because this portion of the bone plays an important rôle in supporting the weight of the body.

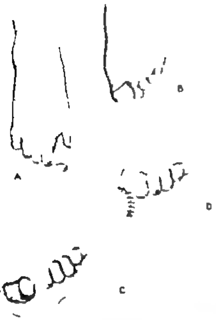
Amputations Through the Foot

Incisions here must be so planned that the scar is on the dorsum of the foot, using a long plantar and a short dorsal flap, whenever possible. Save as much of the foot as possible. Muscles should be sutured, so that the pull of the

tendo Achillis be constructed to prevent the stump from assuming the equinus position.

AMPUTATIONS THROUGH THE METATARSUS

Historical Notes. The ancients practiced [illegible]. Sharp of London performed it in [illegible] and Turner of Yarmouth in [illegible]. This procedure is to be preferred to dis-



[illegible] "Racket" disarticulation of the great toe at the metatarsophalangeal articulation. [illegible] along the anterior and posterior aspects of the line of incision. C, the toe has been [illegible], the flaps are ready for suture. [illegible] the flaps sutured. Observe that the scar [illegible] from pressure.

articulation through the tarsometatarsal joint because the insertions of the most important muscles are retained and movements in all directions are preserved.

Sharp Operation

Mark out a long plantar flap (Fig. [illegible]). Extend the foot strongly. Make the incision. Divide the extensor tendons. Dissect up the flap for a short dis-

tance above the line of division of the metatarsals. Retract. Divide the metatarsals. Bend the foot so that the divided ends of the bones protrude. Remove the bones from the flap by always cutting toward the bone instead of away from it.

Free the flap. Suture the opposing tendons over the ends of the bones. Close the wound by suturing the flap into position. The scar should be on the dorsum of the foot a short distance above the divided bones.

TARSOMETATARSAL DISARTICULATION

Historical Notes. The North American Indians practiced this operation as a means of preventing their prisoners from escaping (Ashhurst). Hey of Leeds recorded the first amputation in [illegible]. The first pure disarticulation was done by Lisfranc in [illegible], which is in vogue at present.

Lisfranc Operation

Lisfranc admonished that "*the secret of facility in the operation lies in hitting the line of the articulation.*" This is best accomplished by locating the joint of the first and fifth metatarsals (Fig. [illegible] [A and B]).

Fig. [illegible]. Outline of incisions [illegible] amputation through the metatarsals of the foot (Sharp [illegible]).

The foot is grasped by an assistant as shown in the illustration (Fig. [illegible] [C, D, E, F]). The forefingers and thumb of the surgeon's left hand mark out the termination of the incision. Locate the joint line. Divide the structures on the dorsum of the foot from the base of the first to the base of the fifth metatarsal bones. Ascertain the position of the joint line by opening the first and fifth tarsometatarsal joints. Flex the foot forcibly and mark out the long plantar flap which extends forward from the points of the dorsal incision along the borders of the foot; it crosses the sole of the foot over the heads of the metatarsal bones. The flap comprises all the structures down to the bones. Put the dorsal ligaments on the stretch by forcibly depressing the foot. Open the three outer joints, then the joints between the first metatarsal and the internal cuneiform bone. Free, lastly, the head of the second metatarsal bone. This is best done by inserting the point of the knife between the two first metatarsals until by a [illegible] motion the lateral ligaments are divided. This procedure is repeated between the second and third metatarsals. Open the joint between the second metatarsal and the middle cuneiform bone. Put the soft parts attached to the plantar surface of the metatarsal bones on the stretch. This is accomplished by pressing the toes backward (toward the heel) and pulling the heads of the metatarsals forward. By directing the knife against the bones the tissue soft parts are divided. The dorsalis pedis and the two plantar arteries are ligated. The opposing tendons are sutured over the tarsus. Unite the flaps. The scar will be dorsal.

Fig. [illegible]. Lisfranc amputation. [illegible] After Bergland.

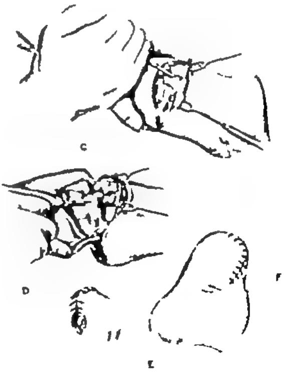


Fig. [illegible]. Lisfranc amputation (Continued). C, [illegible]. D, [illegible]. E, [illegible]. After Bergland.

Hey Operation

This is a modification of Lisfranc operation and consists of sawing off the projecting portion of the cuneiform bone (Fig g). [illegible] recommends Hey procedure and believes it to be superior to Lisfranc operation

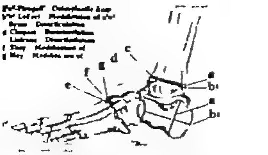


Fig. Various planes for amputations and disarticulations of the foot and ankle.

Skey's Operation

This consists of dividing the base of the second metatarsal bone and the projecting portion of the cuneiform bone (Fig f).

Fig. Incisions for Syme disarticulation at the ankle joint.

Cooper Operation

This consists of disarticulating the first metatarsal and sawing the remaining bones at the same level

Difficulties

Mistakes in locating the joint line

Insufficient covering for the inner aspect of the internal cuneiform

2 Difficulty in disarticulating the head of the second metatarsal bone

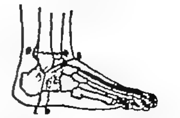


Fig. Syme's method of amputating through the malleoli. Dark area indicates parts ablated.

DISARTICULATION AT THE ANKLE JOINT

Historical Notes. [illegible] in [illegible] first performed the circular method of disarticulation. This was later modified by [illegible], Velpeau and [illegible]. In [illegible] J. Bell used an anterior flap. An anterior flap with sawing off the malleoli was used by [illegible]; [illegible] and [illegible] used double lateral flaps. Antero-external flaps were used by [illegible] and [illegible]. [illegible], [illegible] and [illegible] used internal flaps. [illegible] and [illegible] used external flaps. The heel flap operation was used by Syme in [illegible] while Pirogoff introduced his osteoplastic flap in 1851. [illegible] introduced his osteoplastic procedure which is an osteoplastic modification of Syme operation.

Fig. Circular incision for Pirogoff amputation of the foot.

Chopart Operation

This operation was performed by Chopart in [illegible]. It consists of disarticulation between the astragalus and os calcis posteriorly and the scaphoid and cuboid bones anteriorly. It is performed by long plantar and short anterior flap, similar to Lisfranc operation previously described (Fig f).

While much used in demonstrations, it is seldom practiced and has given way to

Syme's Operation

Step Hold the foot at right angles to the leg. From the tip of the external malleolus to a point one-half inch below the internal malleolus make an an-

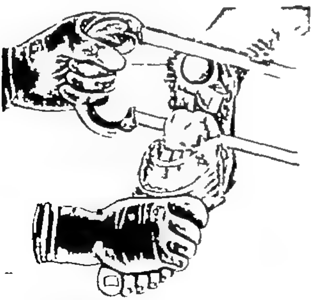


Fig. Division of the os calcis. Pirogoff amputation of the ankle

terior incision down to the bone. Continue the incision across the sole of the foot, its center slightly curved toward the heel. Unite the upper ends of the incision by an incision straight across the front of the ankle joint. This is the so-called "stirrup" incision (Figs. c, [illegible])

Step Put the lateral ligaments on tension by forcibly bending the foot downward. Open the joint. Divide the lateral ligaments. Note: While dividing the soft tissues on the inner aspect of the ankle avoid injuring the posterior tibial artery. Retain as much of this vessel as possible, to insure adequate nourishment of the flap

Step 3 Forcibly bend the foot still further thus separating the surfaces of the

ankle-joint more and more. Expose the tendo Achillis; divide it close to the os calcis. Dissect the heel flap from the os calcis from above downward. Retain the full thickness of the flap and avoid puncturing it while it is being fashioned. Remove the foot

Step 4 A thin piece of bone including both malleoli is sawed from the tibia and fibula

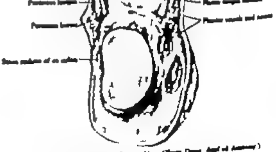


Fig. Pirogoff amputation of the ankle (From [illegible] Atlas of Anatomy)

Step 5 Provide drainage through a perforation in the flap posteriorly

Step 6. Hemostasis. Trim away excess tissue. Suture the flap. Dress

Comment: Do not begin the incision at the internal malleolus. This will give an asymmetrical flap which will be too long and increase the difficulties of the dissection

Pirogoff Osteoplastic Amputation

This consists of an osteoplastic amputation of the ankle joint by means of a heel flap in which the posterior portion of the os calcis is retained and approximated to the sawed off surface of the tibia and fibula

Preliminary to the operation do tenotomy of the tendo Achillis.

Step 1. Hold the foot at right angles to the leg. Locate the joint line.
Step 2. Make stirrup incision as in Syme operation (Fig. [illegible]).
Step 3. Extend the foot and divide the lateral ligaments. Do not injure the lateral posterior tibial artery.
Step 4. Divide the posterior ligament of the ankle joint at its insertion into the astragalus.
Step 5. Saw through the os calcis (Fig. [illegible]).
Step 6. Expose the tibia and fibula at level above the articular surface of the tibia (Fig. [illegible]). Saw the bones at right angles.
Step 7. Ligate the tibialis anterior, peroneal and malleolar arteries.
Step 8. Appose the sawed surfaces accurately. Suture the structures as shown in the illustration (Fig. [illegible]).
Step 9. Apply posterior splint and dressing. Flex the knee. Support by pillows.

AMPUTATION OF THE LEG

Thomas G. Orr concludes that "in selecting site for amputation through the leg, future artificial limb fitting should be kept in mind. It is now considered that amputation through the middle third, and leg stump six to eight inches long, is the most desirable. It is of importance to bear in mind that leg stump shorter than five inches cannot be satisfactorily fitted with an artificial appliance. An amputation at the old 'site of election' four inches below the knee to make 'kneeling stump for peg leg' is no longer recommended" (Fig. [illegible]).

Fig. [illegible]. Scheme of Pirogoff's operation. Heavy outlines and blackened areas show skin and bone removed after other parts are divided.

Where aperiosteal, tenoplastic or osteoplastic methods are used, the source of covering is immaterial so long as the soft parts are sutured without tension. The most generally applicable method the oblique circular. Rest uses large tongue-shaped anterior flap. If unequal flaps are used, the longer one taken from the extensor surface, the shorter one from the flexor surface.

Aperiosteal Amputation of the Leg

This may be performed by the oblique circular, single or double flap methods.

Step 1. Ascertain the line of section of bone (see Figs. [illegible]). Apply tourniquet above the knee. Outline the skin flaps. "The deep fascia should always be included in the anterior skin flap so that the blood supply may be disturbed as little as possible" (Orr) (Fig. [illegible]).
Step 2. Divide the muscles in circular manner about two inches distal from the proposed point of bone section (Fig. [illegible] b).
Step 3. Divide the interosseous membrane. Retract the soft parts with three-tailed linen retractor (Fig. [illegible]).
Step 4. Divide the periosteum by circular incision. Curve downward for distance of about cm. Rotate the leg inward.
Step 5. Divide the bones with saw.

Step 6. Shorten the fibula by removing about an inch of its distal end. Clear the crest of the tibia from periosteum. Saw portion of it off, obliquely.

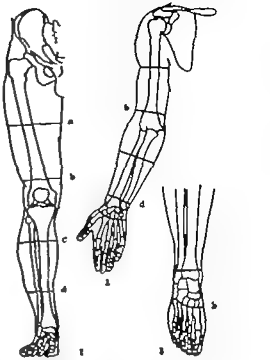


Fig. [illegible]. [illegible]

Smooth the bone edges with rongeur forceps. Scoop out the medullary canal for about one inch (Fig. [illegible] d).
Step 7. Isolate the principal nerve trunks (these are O.T. tibial, saphenous,

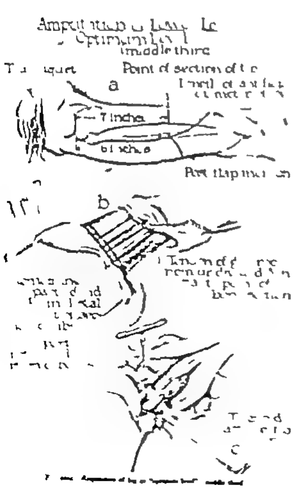


Fig. [illegible]. Amputation of leg at "optimum level," middle third.

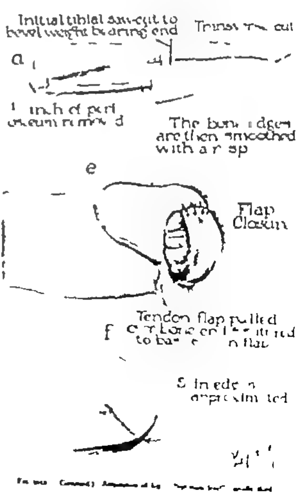


Fig. [illegible]. (Continued.) Amputation of leg "optimum level," middle third.

[illegible] and sural). Inject them with 95% alcohol. Cut them short and allow them to retract. The anterior tibial vessels will be found in the interosseous membrane, the posterior tibial between the deep and superficial posterior muscles and the peroneals in the lower two-thirds of the leg behind the fibula.

Step 6. Release the tourniquet.

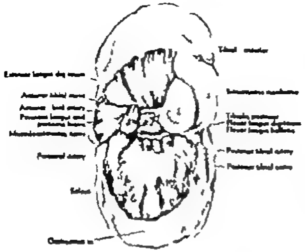


Fig. 1013. Amputation of the upper third of the leg. (From Davis' Applied Anatomy.)

Step 7. *Group the muscles about the ends of the divided bones and suture them over with chromic catgut. If a fascial flap were successfully shaped, it should be brought over the muscle stump (Fig. 1012,).*

Step 8. Attend to hemostasis. Introduce a drainage tube to the muscle plane. Unite the flaps (Fig. 1012, f). Dress.

DISARTICULATION OF THE KNEE

Historical Notes. In 430 B.C. Hippocrates mentioned this procedure. In 1581 Fabricius Hildanus performed the operation at Düsseldorf. It was first performed in America by Nathan Smith in 1824. Velpeau performed it in France in 1830. In 1870 Stephen Smith introduced his method of modified, lateral flaps.

Methods

1. Bilateral Hooded Flaps (Stephen Smith)
2. Oblique Circular Method (Baudens)
3. Anterior Flaps (Nathan Smith)
4. Circular Method (Velpeau)

The best of all of these is the Stephen Smith method. For the walking man this operation has no equal. For those who have chief desire is to ambulate easily, an amputation higher up should be considered.

Stephen Smith Disarticulation

Step 1. Define the level of the knee joint and its surface anatomy.

Step 2. Commence the incision as shown in Fig. 1014, [illegible], in the median on the posterior surface of the limb upon a level with the joint line. The knife is carried down vertically in the midline for about three inches. A lateral flap with its convexity downward is fashioned, its lowest point being a little over an inch below the tubercle of the tibia.

Step 3. Raise the limb and rotate it in the opposite direction and fashion the opposite flap, beginning at the tibial tubercle and extending to the vertical

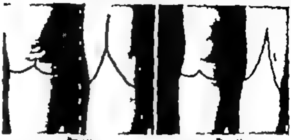


Fig. [illegible] Fig. 1015

Fig. 1014. Incision for Stephen Smith disarticulation of the knee joint. It will be noted that the [illegible] slightly lower [illegible] on the inner side.
Fig. 1015. Showing the [illegible] Stephen Smith disarticulation. [illegible]

median incision. The inner flap should be a little longer than the outer in order to afford ample covering of the large inner condyle. In the dissection of the flaps, the skin, fascia and cellular tissue are raised and the ligamentum patellae is divided. Allow the patella to remain. (Fig. 1015.)

Step 4. Flex the knee. Insert the knife between the tuberosities of the tibia and the semilunar cartilages which are left in contact with the condyles of the femur (Baudens). Sever the crucial ligaments. Complete the disarticulation by dividing the soft tissues.

Step 5. Ligate the popliteal vessels. Isolate the popliteal nerve. Inject it with alcohol. Sever it high and allow it to retract.

Step 6. Unite the flaps. Insert a small rubber drain in the upper angle of the wound. Apply a posterior splint. Dress. Steady with sand bags.

Comment. According to G. L. McWhorter[*] disarticulation at the knee is preferable to guillotine amputation for the reason that it is performed

*Technic of Disarticulation at the Knee, Surg. Clin. N. Amer., [illegible]

at a higher level insuring healthier flaps; infected thrombi are removed from the veins and better circulation is obtained to combat infection. The stump which is left following guillotine amputation offers greater possibility of absorption, infection and sloughing of the tissues. An amputation higher up often has to follow the guillotine method. The death rate is much lower following disarticulation at the knee than after a supracondylar or thigh amputation.

In cases of gangrene, arteriosclerosis and arteriosclerosis, Wilms recommends disarticulation highly. He states that it may be done quickly, does not produce as much shock as a supracondylar amputation, does not open bone channels so that infection is spread and there is no exposure of deep bone spaces. Later on, reamputation may be done at a site distant for an end-bearing stump.

A complete examination is necessary in all patients with gangrene, to determine if septicemia is present and if procrastination is likely to prove fatal, or, if the condition is the result of diabetes and whether preliminary measures, such as food administration, etc., are indicated.

The color and temperature of the skin determine the collateral circulation which is important in determining the level of amputation. If the circulation in both feet is affected and the skin above the line of demarcation is infected, the gangrenous foot may be warmer than the sound one. It is not advisable to apply a tourniquet as employing same more than impairs circulation still further. The patency of the main arteries may be determined by the oscillometer which should be used with great care where there is a spreading infection.

Statistics compiled by Crile show the importance of the anesthetic used as regards the mortality in amputations. *Out of 200 soldiers operated on for thigh amputation under ether anesthesia at* [illegible] *base hospital during the World War, 80 per cent died.* The mortality was approximately 10 per cent in the same number of cases operated on under nitrous oxide and spinal anesthesia. He maintains that a skilled anesthetist is very necessary and that some form of nerve-block is the only way to avoid shock.

Spinal anesthesia is contra-indicated in the presence of septic infection. Gas anesthesia seems to be superior to the other methods but must be administered skillfully. If it cannot be obtained, procaine may be used for regional block in the thigh (which see) for disarticulation at the knee or for amputation of the leg in patients not considered good surgical risks. In such patients very little morphine or none at all is administered as a premedication. At the present one half of 1 per cent of procaine with adrenalin is injected in the shape of a fan in the thigh. Around the larger nerves greater amounts is injected.

McWhorter has been able to obtain a definitely lowered mortality by the use of local or gas anesthesia and the principles advocated here in the treatment of gangrene of the foot. In comparison to a parallel series of cases of amputations of the leg or thigh done by others using ether the mortality has been nearly one-half lower in his series.

McWhorter found a fascial flap modification of the Stephen Smith

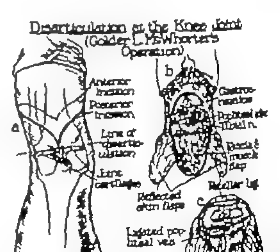


Fig. 1016. Dr. Golder McWhorter's operation for disarticulation at the knee joint.

method of disarticulation at the knee satisfactory. The technic is as follows:

Step 1. A tourniquet may be applied below the level of amputation and above the gangrenous extremity thus preventing the spreading of venous, infected thrombi throughout the body by manipulation.

Step 2. Bilateral skin flaps are used (to form perfect [illegible] long anterior flap). Incisions are begun anteriorly and immediately below the tibial tubercle; these are directed downward and laterally on either side of the affected limb approximately 3 or [illegible] inches below the joint line, then curving upward posteriorly, joining at the level of the joint line in the popliteal space (Fig. [illegible]). The internal flap is somewhat larger so that it may cover the larger internal femoral condyle.

Step 3. Carefully free and retract upward the skin and superficial fascia to the joint line including the lateral capsule of the joint. Retract the skin downward posteriorly over the gastrocnemius muscle so that [illegible] flap of fascia may be cut from here to cover the femoral condyles. After liberating the fascial flap, [illegible] should have some muscle for vascular purposes left attached to the base of the remainder of the gastrocnemius. It is incised transversely at the level of the joint line (Fig. [illegible] b). Locate the popliteal artery and vein separately. Inject the nerves with alcohol and sever at higher level.

Step 4. Cut the patellar ligament transversely at its insertion and open the knee joint by cutting along the upper margin of the tibia leaving the cartilages attached to the femoral condyles. Flex the knee, divide the crucial ligaments and any tendons and muscle attachments at the level of the joint line (Fig. [illegible]). Disarticulation may be done before the popliteal vessels are ligated. The fascial flap may be cut last. The latter is turned forward over the condyles and after the redundant part [illegible] trimmed away, is sutured to the incised patellar ligament and to the capsular ligament and fascia at the sides of the condyles, completely covering the end of the femur (Fig. [illegible] d). Suture the skin flaps in the midline permitting [illegible] soft rubber drain to emerge posteriorly (Fig. [illegible]).

Comment: If high amputation or disarticulation at the knee is contraindicated on account of spreading gangrene or sepsis, it may be advisable to try some other method of relieving the infection and toxemia. A low guillotine amputation seems to offer some advantages over [illegible] higher amputation in lowering toxic and shock but it has other disadvantages.

[illegible] patients who seem to be exceptionally poor surgical risks, Mc Whorter has employed two different methods which have met with [illegible] measure of success.

In the first method, [illegible] tight tourniquet is applied under aseptic conditions around the leg high above the gangrenous area and immediately below the site of future amputation. Energetic systemic treatment is [illegible] the patient for two or three days when amputation may be more safely performed.

A slight degree of pain follows the use of the tourniquet which may be largely allayed by the use of sedatives. It is virtually impossible to

entirely occlude circulation by [illegible] tourniquet around the leg on account of two bones which allow circulation in the soft tissues between them and their blood vessels. The tourniquet, however, has proved valuable in checking toxemia, especially where patients have to be transported for some distance.

The second method resembles the first in its action. The popliteal artery and vein are ligated. Comparing this step with the use of the tourniquet, it has been noticed that following the tourniquet there was improvement as long as the sixth day, while after popliteal ligation the greatest improvement was on the second or third day. It is concluded that amputation or disarticulation may be done more safely after energetic systemic treatment, on the second or third day after either popliteal ligation or the tourniquet application in cases characterized by toxemia.

The experimental and clinical observations of Cannon form the basis of the above two procedures. Cannon was able to relieve shock completely after experimental crushing of [illegible] limb by clamping the blood vessels or applying [illegible] tourniquet proximal to the injury. He also noted the development of shock after removing [illegible] tourniquet from [illegible] patient with [illegible] crushed foot. In [illegible] case of shock too severe to permit movement, there was considerable improvement after [illegible] tourniquet had been applied above the crushed extremity.

AMPUTATIONS IMMEDIATELY ABOVE THE KNEE

Transcondyloid and Supracondyloid Amputations

On the whole the weight bearing qualities of the stump are not as effectual as in disarticulation.

Methods

[illegible] Transcondyloid Femorotibial Osteoplastic—Sabanejeff Operation.
[illegible] Cordro-Rochanne Operation (Transcondyloid)
3. Gritti-Stokes Operation (Supracondyloid)
4. Wilson (Transcondyloid or Supracondyloid Total osteoplastic)

The Gritti-Stokes will be described as it is most commonly used. It gives better results than the Cordro-Rochanne procedure by affording end bearing without adherence between the bone and the skin.

Gritti (1857)-Stokes (1870) Operation

Step 1. Apply [illegible] tourniquet.

[illegible] Incision. A large rectangular flap is fashioned running from [illegible] point just above the base of the condyle on one side to [illegible] corresponding point on the other side and extending downward as low as the upper part of the tuberosity of the tibia. The posterior flap is about one-third the length of the anterior flap. It is fashioned by carrying the knife straight across the back of the limb. Raise the anterior flap, divide the ligamentum patellae (Figs. [illegible], [illegible], p. [illegible]).

Step [illegible]. Open the knee joint, divide the capsule [illegible] as the patella with the anterior flap. Divide the tendons at the back of the joint; see that they

are divided on [illegible] level with the edge of the retracted skin. Raise the posterior flap to the line of bone section.

Step 3. Saw the bone. Retract the anterior flap over the end of the femur. Force the posterior surface of the patella out of the wound and remove its posterior articular cartilage with [illegible] saw. The femur [illegible] sawed through at [illegible] point [illegible] to approximate the posterior surface of the patella. Through the [illegible] made by the saw in the femur [illegible] large amputation knife is introduced, its cutting surface directed somewhat [illegible]. [illegible] the soft tissues including vessels and nerves are divided. A short flap thus results. The freshly cut surface of the patella [illegible] sutured snugly against the end of the femur [illegible] an effort is made to suture the hamstring muscles to the patellar ligament (Fig. [illegible] b). A tenotomy is then performed upon the insertion of the quadriceps muscle.

Step [illegible]. [illegible] ligate the popliteal artery and vein. Sever the sciatic nerve after injecting [illegible] alcohol. Permit it to retract. Hemostasis. Obliterate dead space. Close the flaps. Drain if thought advisable. Dress.

Comment: [illegible] Snyder states that in [illegible] series of cases the Gritti-Stokes type of amputation was carried out at first with much concern as to the outcome but confidence increased with experience. He continues: If we consider that the larger muscle bodies of the thigh are left undisturbed with no sectioning across these structures and no disturbance of their circulation some reason attends this type of procedure. The nutrient artery to the femur enters at [illegible] higher level from the profunda femoris and its division of the femur just above the condyles does not open the marrow cavity of the bone; reasonable assurance of the integrity of the femur may be felt. Disturbing of the stumps of the hamstring muscles is of minor importance, the main question is the viability of the flaps and the patella itself. Apparently the rather free anastomosis about the patella is sufficient to maintain its nutrition and in no case has enough necrosis of the flaps occurred to give concern. In most of the operations the tourniquet has not been applied because of fear of producing damage to the circulation to the thigh. Snyder never felt [illegible] necessary to secure the patella to the femur with sutures or nails as the tension of the quadriceps acting against the patella seems to hold the patella firmly against the femur. Secondary nonabsorbable sutures are however employed. If union of the patella to the femur fails to occur the stump will not be [illegible] from the mechanical standpoint but this has not happened in his series. His conclusions point out that this type of operation will not always be [illegible] but the operation is much less severe on the patient than [illegible] midthigh amputation producing little if any shock when done under [illegible] spinal anesthesia and if successful it gives the patient [illegible] far more satisfactory stump.

AMPUTATION THROUGH THE THIGH

The same principles apply here as in amputation of the arm. Figs. [illegible] and [illegible]. Circular, Oval or Long Posterior and Short Posterior flaps. [illegible] operation may be used. The stump should be at least six or seven inches in length measured from the crotch. The muscles are divided about four inches distal

The femoral [illegible], [illegible]

to the point of division of the femur (Fig. [illegible]). The steps of the operation (osteoplastic amputation of Kirk) are illustrated in Fig. [illegible].

Disarticulation of the Hip

Historical Notes. In [illegible], Ravaton proposed the operation through an external racket incision. The other outstanding surgeons at the time advised against its performance. La Croix of Orleans performed it first in 1748. Perault of St. Maurice, Touraine was the second to perform [illegible] in the same year. Both operations were done on cadavers. According to Gibbons, [illegible] H. Thomson of London who did the first disarticulation of the hip in the living person in [illegible]. In [illegible] Kerr of Northampton employed the oval method. Larrey used this procedure first in military practice in [illegible]. The first American to perform the operation was Walter Brashear of Bards-

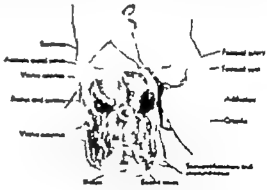


Fig. [illegible]. Amputation just above the middle of the thigh, showing sections of thigh [illegible]. From Gray, Applied Anatomy

town, K[illegible] in 1806. He performed an amputation-exarticulation through an external racket incision.

Methods of Hemostasis. [illegible] Preliminary ligation of the common femoral artery or the external iliac artery.

[illegible] Temporary digital or instrumental control of the iliac artery through an abdominal incision (McBurney).

3. Compression of the abdominal aorta (Momburg).

The [illegible] here is direct compression of the aorta. An assistant stands on [illegible] stool to the left of the patient. He forcibly pushes his clenched [illegible] fist [illegible] against the anterior abdominal wall which is pressed against the aorta with the anterior abdominal wall. The fist is applied immediately below the umbilicus to the left and the assistant brings his whole body weight by crossing the feet in front of the left. This is [illegible] simple and efficient but fatiguing [illegible] (Fig. [illegible], p. [illegible]).

[illegible] Compression of the vessels by [illegible] figure-of-eight tourniquet.

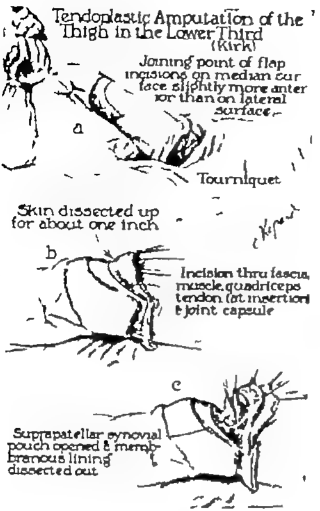


Fig. [illegible]. Tendoplastic amputation of the thigh in the lower third.

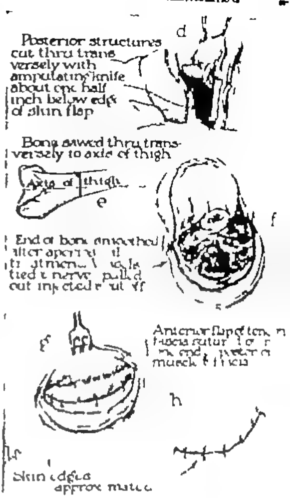


Fig. [illegible]. (Continued.) Tendoplastic amputation of the thigh in the lower third.

5. Lynn-Thomas forceps tourniquet.

The Lynn-Thomas forceps is a long instrument not unlike a gastrectomy clamp, one blade of which is passed through the soft tissues, the other blade compressing the tissues externally.

6. Wyeth's bloodless method. Two 10-inch pins are passed through the root of the thigh. The first one is inserted slightly below and internal to the anterior superior spine, passing superficially, engaging only the skin and fascia lata. The second pin is pushed through the adductor longus. It enters one-half inch below the perineum and emerges one inch below the tuberosity of the ischium. An elastic tourniquet is wound above these pins (Fig. [illegible]).

7. Mechanical Compression of the Abdominal Aorta. An abdominal tourniquet may be used or Momburg's Constrictor may be employed.

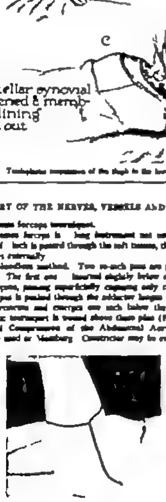


Fig. [illegible]. [illegible] for Furneaux Jordan's disarticulation at the hip. [illegible] the dot appears on the level of the crest of the ilium while the other is placed [illegible] of the great trochanter.

In [illegible], Momburg demonstrated that Esmarch's principle may be applied to the compression of the abdominal aorta. The method consists of putting a soft rubber tube (10-15 mm. diameter) at full tension under the patient and winding it around the waist until the femoral pulse disappears. When the ends of the stretched rubber tube are secured with a clamp, secondary constrictors are applied to both thighs just below Poupart's ligament and below the popliteal spaces. When the operation is completed the abdominal constrictor is loosened and the secondary constrictors loosened one by one—the general circulation thus gradually restored and sudden excessive strain on the heart avoided.

While in certain cases no other method will accomplish the desired end as effectually as Momburg's procedure, yet, deaths from acute dilatation of the heart, shock, urinary suppression (transitory), etc., have been reported from its use.

Furneaux-Jordan Method

Step 1. The patient is placed on his back with the buttocks resting on the extreme end of the table. Outline the position of the crest of the ilium and the top of the great trochanter by two dots of iodine (Fig. [illegible]).

Step 2. Divide the muscular attachments from the femur to the great trochanter and expose the hip joint. Separate the soft parts with a periosteal elevator, knife or scissors for the full length of the longitudinal incision.

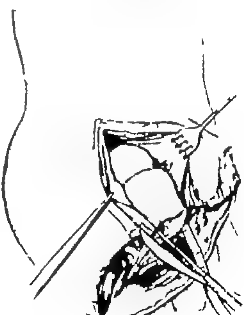


Fig. [illegible]. Disarticulation of the hip.

Step 3. Dislocate the femur and have it protrude through the wound (Fig. [illegible]). Introduce a closed forceps through the wound and force it through the tissues on the inner surface of the thigh, causing a prominence on the skin. With a scalpel divide the skin there made to project on the tip of the forceps. Grasp in these forceps the middle of a length of rubber tubing and pull it through the wound and cut it through where it was grasped by the forceps. This leaves two portions of tubing passing completely through the

thigh. One of these tubes is tightly passed around the anterior, the other around the posterior mass of tissues. This will give ample hemostasis during the rest of the operation.

Step 4. Attend to hemostasis. Drain, if it seems advisable. Dress.

If for some reason this method is not applicable (extensive damage to the soft tissues, tumor involving the skin) amputation by lateral flaps, the so-called Anterior Racket Method (Fig. [illegible]) may be used. This produces more shock than the foregoing. The first step here consists of exposing and ligating the femoral vessels.

Fig. [illegible]. Incision for the anterior racket disarticulation of the hip.

INTERILIOABDOMINAL AMPUTATION

Jaboulay Operation

Historical Notes. In [illegible] Billroth, according to Kleyn, performed the operation. The patient died. In [illegible] Jaboulay performed and thoroughly described the procedure. Others who have done pioneer work in this field were Girard, Chavasse, Schmiedel and Kocher in Europe and Keen and Freeman in America. [illegible] performed a method of interilioabdominal amputation in which some of the thigh muscles are retained. All of the innominate bone together with a part of the lower abdominal wall are removed at once. The operation is a very severe undertaking. It should be undertaken by experienced surgeons only. The mortality is well above [illegible]%.

Step [illegible]. An incision is begun at the symphysis of the pubic bone parallel to and below Poupart's ligament. It is continued along the whole length of the whole crest of the ilium. The peritoneum is exposed without opening it. It is separated from the structures by gauze dissection until the common iliac artery is exposed. This vessel is doubly ligated and divided. The common iliac vein is treated similarly.

Step 2. A circular incision is now made completely around the thigh at the junction of its middle and upper thirds. This incision goes through the skin and subcutaneous tissues. From a point in the median line on the anterior surface of the thigh an incision is made, the direction of which is directed upward and outward, extending from the circular incision already made to the os pubis. A similar incision is made beginning at the same point, extending upward to the anterior superior spine. These two incisions extending to the incision already made outline a triangular section of skin which is removed. A large posterior cuff-like flap is outlined and dissected up exposing the entire base of the thigh.

Step 3. The spermatic cord in the male and the round ligament in the female are displaced inward and upward. The rectus abdominis and pyramidalis muscles are detached on the affected side from their pubic insertions and the symphysis pubis is divided with a powerful knife. The ischiopubic rami are freed by detaching muscles, fascia and the corpus cavernosum and the thigh is forcibly abducted making the symphysis gape. While further abducting the limb, separate the structures attached on the inner surface of the ilium. The psoas muscle is divided. If the structures attached to the inner aspect of the ilium are involved, remove them. The sacro-iliac articulation is exposed and divided from within outward. The structures escaping through the sacrosciatic notches are severed. Remove the limb and corresponding portion of the pelvis.

Step 4. Hemostasis. Close the tremendous wound by the large flap and apply voluminous dressings.

HISTORICAL DEVELOPMENT OF ARTIFICIAL LIMBS

The number who survived major amputations in the days before ligatures and antiseptic dressings were used was small. The peg-leg seems to have been employed from the earliest days of history. There are fragments of an ancient peg-leg (Roman) in the museum of the Royal College of Surgeons of England, which was found in a tomb in Capua, Italy and believed to have been placed there about 300 B.C.

A story is told by Herodotus concerning an Elean seer, Hegesistratus, who about 500 B.C., was condemned to death by the Spartans but escaped from prison by cutting off his foot which was fastened in the stocks. Subsequently, he fashioned himself a foot of wood which enabled him to travel about fulfilling his duties as soothsayer and adviser to the Persian army until the Spartans again captured him and put him to death. It thus appears that the first Syme operation was self-performed.

A story is told by Pliny about a Roman general, Marcus Sergius, who replaced with an iron hand the right hand he lost in the Second Punic War 218–201 B.C. Barbarossa Horuk, a famous pirate, lost his right hand in a battle with Spaniards early in the sixteenth century and replaced it with an iron hand. A few years later Mazzanti praised lost an arm in the battle of Pavia and replaced it with an iron one.

The mailed fist made in [illegible] for Goetz von Berlichingen was the first classic example of an early artificial hand. This hand may now be seen in the [illegible] Museum. The mailed fist of the knight has been preserved to this instance; the jointed fingers are equipped with pawls and ratchets so that the hilt of a sword could be grasped one-like. According to the [illegible] written about it, it was quite satisfactory. There were many other mechanical hands devised at this period; the earlier ones had to be closed with the good hand, later the fingers were held by a cord anchored to the opposite shoulder similar to the modern appliances.

Before antisepsis was considered important in connection with surgery the demand for artificial limbs was not great. Amputations were often fatal and the custom

of cauterizing the stump with boiling oil failed to make further living desirable to the patient.

Paré introduced ligatures to replace boiling oil in dealing with amputations during his time of serving as military surgeon with the French army in Italy. In his provisional work on surgery published in [illegible] he describes artificial legs and arms which he says may be made by any cunning craftsman. The leg he describes is one suitable for [illegible] knight. The short metal plates here a peg leg and gave the appearance of armour in the case of thigh amputations. The knee was jointed so that the wearer could sit on horse and fitted with a latch so it could be made rigid for walking. A leg of this type could, of course, only be afforded by the rich so Paré also depicted a common peg-leg which he called the "poor man's leg."

Little progress was made in the manufacture of artificial limbs until the 19th century. In the 17th century however Verduin, a Dutch surgeon fashioned a leg with wooden foot and a leather lined copper socket for the stump support, equipped with thigh lacer but it was not received favorably at the time; however a century later his principle was employed in making the modern appliances.

The Marquis of Anglesey lost a leg in the Battle of Waterloo and had an artificial one fashioned for him by James Potts of London. It was a wooden affair with knee and ankle joints controlled by cords. The Anglesey leg was the forerunner of the American leg.

Dr. B. F. Palmer purchased an artificial leg from William Selpho who formerly worked for James Potts, and proceeded to improve upon it. He patented the improved limb in 1846 and in 1851 won a prize at the London Exhibition. Later Dr. Bly invented a ball-and-socket ankle joint; this was followed by Marks' invention which did away with the movable ankle joint and in its place introduced the rubber foot. He also conceived the idea of covering the wooden leg with parchment to keep it from checking and splitting.

The Civil War served to give great stimulus to the artificial limb business and between 1861 and 1865 there were 199 patents issued on these items. In Paris, in 1867, [illegible] de Beaufort published a pamphlet in which he describes the kneeling peg-leg and another made of wood and leather, the last being a short socket with no ankle joint. With a few modifications this type was popular in France until the World War. The peg-leg was common in Germany following the Franco-Prussian War.

The so-called American leg began to gain popularity in 1915 when American firms established branches in European countries. Its superiority was so obvious that it met with little opposition. According to information obtained by the United States Government in 1917 with reference to supplying soldiers with limbs, limb makers of this country were able to turn out 5000 limbs per month over and above the number necessary to supply civilians. Shortly after this the Association of Limb Manufacturers of America was formed "to promote fraternal relations and friendly intercourse between the manufacturers of artificial limbs, and to guard against any ill feelings between members, to discountenance all customs and to antagonize with sound business principles and to elevate our industry to the plane of dignity and importance deserved."

ARTIFICIAL ARMS

It is generally agreed by orthopedists and prosthetists that artificial arms are less helpful to their held than artificial legs. Since the leg is used principally as a means of support while the uses of the hand are of an entirely different nature, it can be said [illegible] realized that the best that can be expected from an artificial arm and hand is one that will give a good appearance and be used for grasping. Thus the artificial hand may be equipped with a hook or other mechanical device so that it may be useful during working hours and skilfully concealed at other times.

At the beginning of the 19th century the greatest progress was made in the manufacture of artificial hands. Peter Baliff, a Berlin dentist devised a method of automatic control for an arm prosthesis, by means of a cord attached to the opposite shoulder enabling the amputee to extend or flex the fingers.

About 1900, Dr. Coquelliers, of Mont Louis, France, had the village blacksmith fashion an attachment for an arm stump which enabled the wearer to use the common farm implements, hoe, and spade were used and the wearer was harnessed to his tools. In his writings, Coquelliers had little regard for the prostheses of forms which enabled a man to tip his hat or carry his cane but was far more interested in something which would enable a poor man to move sidehoes. He made no profit on these devices and willed them to all who would use them.

Since there were a great many more Europeans who lost arms and hands during the World War than Americans, they have had much more experience in arduous these mechanical aids. In this connection, we quote a statement by Captain A. Bement, Maxwell, whose arm has been amputated: "After having tested most of the mechanical hands in this country and studied the best of those available on the Continent, I have come to the conclusion that from the point of view of practical utility, appliances are superior to mechanical hands. . . . Our experience goes to prove that plain hooks, split hooks, claw hooks, spade and shovel grips and tool holders of various designs, are much more useful for manual labor than any of our mechanical hands."

For a thorough survey on the subject, the reader is referred to John Culbert Faries splendid little monograph on "LIMBS FOR THE LIMBLESS" published by the Institute for the Crippled and Disabled, New York, 1934, and from which the above is quoted.

CHAPTER 24

FRACTURES AND DISLOCATIONS

GENERAL REMARKS

The success of immediate or emergency treatment of fractures and dislocations is dependent mainly upon two points. First, the prevention of further injury following the accident and second, the care of systemic damage done by the accident. These points apply whether the subsequent treatment is manipulative or by open surgical operation.

The first point is usually carried out at the scene of the accident and attained by rapidly determining the extent of injury and applying an improvised splint which corrects gross deformities and prevents further motion of the affected area (Figs. [illegible]).

Fig. [illegible]. Emergency dressings for injuries [illegible] about the shoulder region [illegible] about the lower humerus and forearm.

The second point has to do with the management during the interval between the accident and the time of reduction of the fracture or dislocation. Its purpose is designed to prevent contamination by simply covering open wounds with sterile dressings, to prevent exsanguination by the emergency control of hemorrhage and more frequently to prevent and treat shock by gentle handling, administration of sedatives and stimulants, preservation of body heat and immediate hospitalization.

It must be borne in mind that any fracture produces a certain amount of systemic trauma. Likewise the force that produces a fracture may create an injury to soft tissues more serious than the bony deformity. Treatment is therefore designed first to care for the patient in general, then to reduce the ac-

companying fracture. This, however, does not mean that fractures should not be immediately reduced—all fractures should be placed in the best possible alignment as soon as the patient's general condition permits the procedure.

In present-day practice, the manipulative methods of treating fractures and dislocations are most generally followed. This is especially true of the so-called

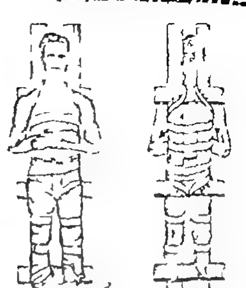


Fig. [illegible]. "Ladder splint" for the emergency treatment of fractures of the [illegible] and [illegible].

"closed type" of injuries. In a majority of cases these methods give satisfactory results and are generally preferred by the patient rather than open surgical procedures. The object of the reduction of a fracture should be to restore complete function to the part as soon as possible by [illegible] bony union and to prevent any [illegible] deformity. A reduction is said to be anatomic when the displaced fragments are restored to their normal relations. It is said to be functional when the displaced fragments are so arranged that when healing occurs function is not impaired although the fragments were not completely restored to their normal relations (Figs. [illegible]).

Manipulative methods for the reduction of fractures do not always give satisfactory results. A faulty union may form or considerable disfigurement result and sometimes there is non-union or only fibrous union and a false joint. In such cases, as well as in compound and badly comminuted fractures, open

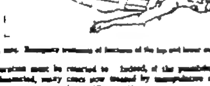


Fig. [illegible]. Emergency treatment of fractures of the hip and lower extremity.

surgical operation must be resorted to. Indeed, if the possibility of infection could be eliminated, many cases now treated by manipulative methods would receive primary open surgical care (Fig. [illegible]).

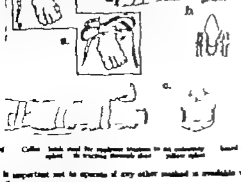


Fig. [illegible]. Colles' [illegible] used for emergency treatment to an extremity. [illegible] board and blanket splint. [illegible] traction [illegible] pillow splint.

It is important not to operate if any other method is available which will answer the purpose.

Do not operate just to get a good looking x-ray—one aims at function—not at pictures.

In charting a course to pursue, select always the easiest way out of the lesion (tongs, Steinmann's pin, etc.) in preference to major surgical procedures

such as Lane plates, bony grafts, etc., provided, however, one can anticipate rather favorable result. When in doubt, choose a minor intervention in preference to a major one.

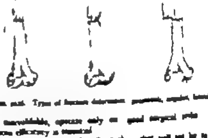


Fig. [illegible]. Types of fracture deformities: [illegible], angular, lateral.

Unless unavoidable, operate only on a good surgical risk. Moreover operating room efficiency is essential.

Justly Cotton admonishes that the technic that will get by in industrial surgery is not good enough here. In this type of work the surgeon should be

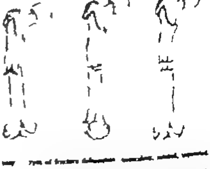


Fig. [illegible]. Types of fracture deformities: [illegible], rotated, separated.

experienced and have at his command adequate assistants. He goes a step further and says "not to operate with others about you ... [illegible] of any kind avoid it. In a technic that has come to be habitual teamwork, all participants bring on the chart for "breaks" in technic, the unexpected does not happen.

Either one should do his own splinting or have it done by a truly skilled assistant.

Often failures result from slip-shod catchiness and inexperienced after-care.

Speed, not haste, is essential.

Handle tissues carefully. I have observed many self-styled "traumatic surgeons" [illegible] the appliances. There is nothing more distressing than to [illegible] such surgery recall dismemberment by [illegible].

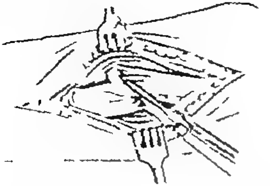


Fig. [illegible] fracture. The [illegible] hole [illegible] between the fragments; the fracture [illegible] into position. After [illegible].

Thorough hemostasis is essential. Before closing any wound, the surgeon should train himself to enjoy a "lingering period" during which he carefully scrutinizes the field of operation and assures himself that there are no sutures missing or bleeding areas.

One should not be a slave to any rigid rule of drainage. The case in point should suggest the type of drainage indicated.

Where there is sepsis, operation must be avoided.

COMPOUND OR OPEN FRACTURES

Operation is indicated in almost every instance where the fracture is exposed to the air through an open wound. The procedure differs according to the type of injury and condition of the patient, as well as the available facilities. The following is cited as an example:

Step 1. Anesthetize the patient. Scrub the entire limb with hot water and soap then shave. Remove grease by scrubbing the whole extremity with turpentine, gasoline or ether. Again scrub the limb with soap and water, followed by alcohol and some standard antiseptic solution. Drench method of preparing the patient excludes water. It consists simply of shaving off the hair of the affected limb, which is painted with tincture of iodine. Apply an elastic constrictor.

Step 2. Obtain ample exposure of the deep wound by enlarging the skin wound. Remove all blood-clots and debris with gauze sponges, gloved finger and instruments. Trim every piece of subcutaneous, devitalized tissue and traumatized tissues. Remove all detached bone fragments and place them in a warm aseptic solution to be reimplanted if possible or deemed advisable. Open all torn tissue spaces and muscular planes and irrigate thoroughly with mild antiseptic solution. If much dirt is ingrained into the tissues, scrub the wound with brushes followed by alcohol. Institute free drainage through counter-openings when deemed advisable.

Step 3. Reduce the fracture. This is accomplished by the same methods as are resorted to in simple fractures. Later, if need be, resort to open operation (Figs. [illegible], p. [illegible]). Control hemorrhage by means of ligatures, hemostatic hot packs, etc.

Step 4. Close the surface wound partially. Dress. Immobilize the affected limb in the position indicated by a given case.

Figs. [illegible]. [illegible] the fragments of the fracture [illegible] introduced into the [illegible] after [illegible] [illegible] may be used to immobilize [illegible] C. [illegible]

DIRECT SKELETAL EXTENSION IN FRACTURES

Traction directly upon the skeleton may be secured by nails, pins, wires and calipers. This form of extension is of special value to overcome shortening and produce alignment of fractures near the ends of bones and those in which skin areas have been injured. The lower extremity lends itself well to this procedure.

Nail extension is applied to overcome the shortening which prevents correct replacement of bone ends in recent fractures or for malunited old fractures. It is used especially in fractures of the lower limb. Fracture of the femur will be given as an example.

Step 1. Incisions are made down upon the lateral subcutaneous aspects of the femoral condyles exactly on the same level.

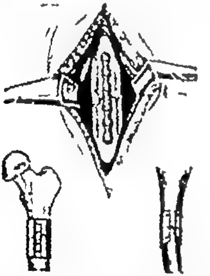
Step 2. A drill is carried through the head of the femur and a metal pin is passed through the drill hole. Cords are attached to the two ends of the rod and to the loop formed by them the extension weight is attached. Instead of a rod, short nails inserted on each side may be employed.

Step 3. The extension is kept up until the soft parts have been partially extended and the bone ends meet properly.

VALUE OF CLOSING COMPOUND FRACTURES BY SKIN PLASTIC

Hospitalization, suffering, deformities and deaths have been shortened by the early closing of compound fracture. The employment of aseptic and antiseptic

first aid measures is most helpful. John E. Cannaday advises the immediate application of sheet saturated with tincture of iodine, mercurochrome or picric acid solution, immobilization of the limb and the patient sent to the hospital.



[illegible]

If the patient is not in state of shock, debride and disinfect the wound, remove superficial, injured tissue. Incise the skin edges by cutting them all the way around and suture them with sutures, carefully. Do not turn the edges of the skin inward but sew them so that they point upward resembling the apex of an inverted V.

Plastic Methods

If the edges cannot be brought together in the usual way, Cannaday advises that long incisions be made at some distance from the opening so that the edges can be moved over the bone without too much tension (Figs. [illegible]). These incisions are preferably made through the outer fascial covering of the muscles. [illegible]

This promotes circulation and lessens the tendency toward edema. This may be done under local anesthesia. A prophylactic injection of antitetanic serum should always be administered. Cannaday and Hennett report no cases of primary union out of [illegible] cases of compound fracture treated in the manner described. They contend this is far superior to the open method. The bone is protected

Fig. [illegible]. Compound fracture of the tibia with extensive exposure of bone at point of fracture. Fig. [illegible]. Same [illegible] [illegible] wound after [illegible] of fracture. (Cannaday)

at the fracture site thus preventing the formation of dense scar tissue and deformities.

IMMOBILIZATION FOR MOTILITY AND FOR FIXED JOINT

Immobilization of an injured joint demands particular attention if there is reason to suspect that the ultimate range will not be regained.

The chief factors to be taken into consideration are:

The best position, from a standpoint of usefulness, for a fixed joint or one with very little mobilization.

The movements of any joint, certain of which are easily regained while others, once lost, are difficult to regain.

The occupation of the patient.

Shoulder. Abduct the shoulder [illegible] degrees if a mobile joint is desired. Where mobility is not desired abduct the shoulder [illegible] degrees in a child, [illegible] degrees in an adult and [illegible] degrees forward of the coronal plane of the body and [illegible] degrees external rotation.

Elbow. Flex the elbow [illegible] degrees if mobility is desired. For a fixed joint in women flex the elbow at [illegible] degrees; for a working man or ball player [illegible]

the elbow at an open angle of 30 degrees, that is, approximately half way between full extension and a right angle.

Forearm. If motion is expected to be re-established, immobilize the forearm in full supination. If a fixed arm is expected, place the elbow at midposition between pronation and supination.

Wrist. The wrist should be dorsiflexed 20 degrees for either a fixed or mobile joint. The fingers and metacarpophalangeal joints should be left free.

Hip. Abduct the hip 10 degrees and flex it 5 degrees and rotate it externally 5 degrees, if a fixed hip-joint is expected. Thirty degrees is the most desirable degree of flexion as this will permit a comfortable sitting position as well as standing posture. However, 5 degrees usually suffices as the degree of flexion aimed at is in most cases exceeded. To retain mobility the hip-joint should be fixed in complete abduction and extension.

FIG. 1033. Sternoclavicular articulations from before (clavicle [illegible]) (after Poirier.)

Knee. Where either a mobile or fixed joint is expected, completely extend the knee but do not hyperextend it. Its lower aspect should be protected from strain as long immobilization tends to produce a genu [illegible].

Ankle. Fix the ankle at 85 degrees for both a fixed and mobile joint. Support the sole properly—it should rest on a molded surface resembling the natural contour of the foot and supporting both arches.

DISLOCATIONS AND FRACTURES OF THE UPPER LIMB

DISLOCATION OF THE CLAVICLE

The maintenance of the sternoclavicular joint depends upon the integrity of its ligamentous connections and when these are ruptured, even if there is no loss of continuity in the bony tissue, the clavicle becomes dislocated (Figs. 1033, 1034, 1035). In old-standing cases reduction by any manipulative procedure is practically impossible and open surgical operation is the only method of obtaining satisfactory results. Care must be exerted, however, as suturing in this subcutaneous region is especially liable to suppuration.

Dislocation of the Sternal End of the Clavicle

Step 1. The approach to the joint is by a semilunar incision with its base downward. The soft tissues are incised and retracted and the ruptured ligaments are searched for.

Step 2. When the ligaments are found the clavicle is put in proper anatomic

position and the ligaments are sutured over it. It may be necessary to use any fascia or other tissue in the vicinity to strengthen the suture line. In some cases a transplanted piece of fascia is employed for reinforcement.

Step 3. The soft tissues are sutured and the external wound closed. Suitable splints and bandages are applied. The arm on the affected side is immobilized in a plaster Velpeau-like case which must be maintained for three to six weeks.


FIG. 1034. FIG. 1035.
FIG. 1034. Acromioclavicular dislocation.
FIG. 1035. Acromioclavicular dislocation. Posterior view.

Dislocation of Acromial End of the Clavicle

In recent old standing cases, complete anatomic reduction and retention can best be accomplished by open surgical operation.

Step 1. Expose the joint by a semilunar incision with its base toward the neck. Retraction of soft parts.

Step 2. Locate and clean the bone ends. Drill corresponding holes in the clavicle and acromion process and fix the two bony surfaces in correct position by either kangaroo tendon sutures or silver wire which should be made to embrace the coraco-acromial ligament, clavicle and acromial process.

Step 3. Suture the soft parts over the joint and close the external wound. The arm is immobilized in a position of abduction and the applied plaster cast is kept on for a period of at least five weeks.

Comment. Commenting on Acromioclavicular Dislocation and Its Repair, Frederick Jay Cotton and Gordon M. Morrison state the following:

"The understanding of this dislocation, appreciation of its mechanism and of the various problems offered in the handling of the injury, have not been helped by the confusion between two lesions different enough to be classed entirely apart.

"The common lesion, occurring usually from falls on the shoulder,

New England Jour. of Med. Vol. [illegible], [illegible] May [illegible], 1931

common on the football field for instance, involves nothing beyond tearing of the ligaments directly connecting the clavicle and the acromion.

"Sometimes there is a crumpling fracture of the outer end of the clavicle, but not often. There is a little upward displacement of the upper end of the clavicle, usually only a half an inch or so. Unless there is much muscle spasm this displacement is reducible by shoving the arm upward, particularly with the patient on his back.

"Treatment with any sling or apparatus to hold the whole arm up beyond the ordinary carrying point, brings about prompt healing of ligaments with displacement nearly enough abolished to leave no measurable disability as a rule.

"Rarely it may seem advisable to suture the ligaments or to reeve a fascial strip through the bones across the joint. This lesion is really hardly important.

"The other lesion, from like violence but of severer force, involves not only a tearing of the ligaments about the joint, but also of the massive coracoid and trapezoid ligaments holding the clavicle to the coracoid process of the scapula. Such a tear may be so complete as to allow a direct displacement of the outer end of the clavicle upward. In two such cases, rather neglected, I have seen such displacement of at least two to three inches. Ordinarily it is less, but very definitely more than in the lesion first described. The bone-end may be replaced but not easily and is hard to hold. Such an injury is serious. Mere confinement after reduction is entirely inadequate treatment. Even operation at the joint is a waste of time.

"Radical operation is the only cure. Various lashings have been used, but today one would use only fascia. The only valuable treatment is an operation of obvious mechanics, but one I think not often done. The incision runs from the pectoral insertion on the humerus up to and a bit beyond the clavicle, arching about an inch and a half outside the outer end. This incision opens directly onto the interval between the deltoid and the so-called clavicular portion of the pectoralis major. Here lies the cephalic vein. Blunt dissection separates the muscles. The vein is carried outward; occasional ties may be needed.

"High up in the space the coracoid process presents an obvious hook. From it arise the tendons of origin of the pectoralis minor and the short head of the biceps. Blunt dissection opens up room behind these thereby permitting a circling of the curved hook. Directly above this point the clavicle, here broadened out, is drilled through but not countersunk. It is drilled from above downward, a spatula being held beneath it, to guard against any slip. The hole is enlarged to a quarter or even a third of an inch (Fig. 1036).

"The fascia, a long and very strong strip, is obtained from the fascia lata in the usual way, cleaned, rolled up to a cord, passed down through the clavicle under the coracoid from within outward (behind the tendons so it cannot slip off) brought up and forward, tied in a square knot with free end lying in front just below the clavicle. The knot is caught with stitches of chromic gut or silk as usual. Next comes the repair of

the acromioclavicular ligaments, probably not very important. After the operation, firm sling support is needed for at least six weeks.

As in all surgery with fascial sutures, there is presently some slack no matter how tight the fascia is drawn, and how firmly knotted. I have done this operation on about six cases. In all that I have done or observed, thus operated on, the results have been mechanically competent and clinically good. And this applies to several cases operated some weeks after injury."

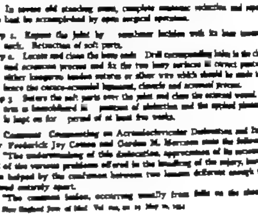


FIG. 1036. Acromioclavicular fixation. [illegible]

FRACTURES OF THE CLAVICLE

Simple fractures of the clavicle with little or no displacement of fragments rarely call for more than support of the upper limb with a suitable sling and the use of one of the many methods which have been devised for immobilizing the clavicle as far as possible. One represents the so-called "anatomical treatment". Even in complete fractures with considerable displacement of the fragments, manipulative reduction of the fracture is generally easy; but maintenance of the fragments in close apposition, especially in restless young patients, is, when this type of fracture is present, generally not, without open surgery, practically impossible (Fig. 1037). Nevertheless, unless a generally deformed with only a moderate amount of callus and without much apparent deformity. An ideal anatomic union of the fractured bone ends is scarcely ever obtained. For these and other reasons some surgeons advocate open surgical reduction and

fracture of all complete clavicular fractures from the first, or at least when, following manipulative reduction, much displacement and overriding of the fragments persist.

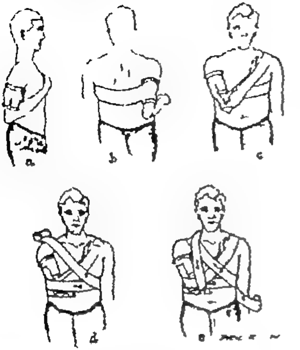


Fig. [illegible]. [illegible] shoulder [illegible] held back by [illegible] adhesive [illegible] [illegible]

Open operative treatment of clavicular fractures [illegible] indicated under certain conditions (Figs. [illegible]) viz:

[illegible] In certain compound or comminuted fractures due to [illegible] crushing or other violent injury.

In recent irreducible fractures.

3 When [illegible] fracture has healed with considerable deformity due to overlapping of the fragments and shortening of the clavicle.

When there [illegible] non-union or very fibrous union of the fragments continuing for [illegible] considerable time after the fracture.

When there [illegible] serious functional impairment of the arm or hand owing to the fracture fragments or callus involving the brachial plexus or the subclavian or other blood vessels in the immediate vicinity of the clavicle.

In bilateral clavicular fractures. An open surgical operation may therefore be indicated either immediately following or at [illegible] considerable time after the actual injury.

The technic most generally adopted is as follows:

Step [illegible] An incision at least [illegible] inches long is made parallel to the line of the acromioclavicular joint. The incision [illegible] made either immediately over the bone or curved [illegible] so that [illegible] flap of the soft parts can be turned up before the bone [illegible] exposed. The latter has the advantage that the clavicle can be covered with intact skin, which is particularly desirable to avoid [illegible] disfiguring scar in the case of women. If the particular case demands it [illegible] incision can be made along the posterior border of the clavicle.

Step [illegible] The site of fracture [illegible] exposed, the bone ends freed and all callus removed. According to the degree of separation of the fragments the surgeon will have to decide upon the method of osteosynthesis to be employed, namely drilling and suturing the two ends, wiring, plating or bone graft. If [illegible] drill [illegible] used care must be taken not to injure the underlying subclavian vessels. If [illegible] metal plate [illegible] used it must of course first be molded to the shape of the bone and then screwed into place. These metal plates are liable to give rise to irritation and lead to infection. The tibial or rib bone graft method seems to be best when there is considerable separation of the fragments and in the case of old ununited fractures.

Step 3 In the case of [illegible] bone graft the periosteum is stripped from the fractured bone ends for [illegible] few centimeters, the bone ends are freely freshened and [illegible] [illegible] intramedullary graft is secured by kangaroo tendon sutures passed through holes made in the graft and the bone ends. The stripped periosteum and soft parts are then sutured over the graft and the external wound closed. A resistant dressing must be placed just as if no operative reduction had been made.

Step [illegible] As soon as union of the graft has been verified by x-ray investigation, the shoulder and, if necessary, the arm and wrist are immobilized in [illegible] plaster of Paris dressing for several weeks until solid union takes place between them and the graft. If the osteosynthesis has been performed by means of wiring or plating, these foreign bodies, when causing irritation, should be removed at this time.

It should be emphasized that in any method of osteosynthesis the most important postoperative procedure is the means of securing completion of the fragments so that recurrence will not take place.

[illegible] of what has been said above [illegible] also apply to cases of open surgical operation on other bones when there is faulty union or non-union of the bone

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Fig. [illegible]. Fracture of the clavicle. [illegible]

Fig. [illegible]. Fracture [illegible] the clavicle. Same patient after open reduction and [illegible]

Fig. [illegible]. [illegible] of the clavicle. Same patient. Final result.

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fragments, and [illegible] will not be necessary to repeat the subject matter when dealing with these conditions.

FRACTURES OF THE SCAPULA

Fractures of the scapula are rare except in severe accidents and they are then usually associated with other injuries. Closed fractures, whether of the body of the neck or glenoid process of the scapula, are almost always treated by manipulative methods by which good results are usually obtained (Fig. [illegible]).

Open surgical operation is indicated in the case of non-union or when apposition of the fragments by manipulative measures is unsuccessful, also in the case of compound fractures. The incision is made over the site of fracture and the

Fig. [illegible]. Fracture [illegible] neck of scapula [illegible]

fragments are held in anatomical position by [illegible] wiring or heavy absorbable sutures; small spicules of bone are removed. The same precautions during and after operation are taken as have been described for fractures of the clavicle.

DISLOCATION OF THE SHOULDER JOINT

This may result from falling on the shoulder or hand. In the usual case (subcoracoid) the head of the humerus follows [illegible] downward and forward direction and comes to rest below and outside the coracoid process.

It should be remembered in diagnosing this condition that the contour of the shoulder is flat and the acromion process very noticeable. The axis of the arm is oblique, being directed upward and inward and displacing the elbow from the side. The fingers of the surgeon inserted under the acromion process will find that the head of the humerus is absent from its normal location and instead a bony lump is felt immediately under the coracoid which with gentle rotation the arm will prove to be [illegible] head. The arm is helpless, no motion being

at the shoulder joint. This condition is sometimes not diagnosed as after the first shock the pain is not great and some movement (scapular) may be possible. X-ray and palpation should confirm the diagnosis (Figs. [illegible]).

The subscapularis muscle obstructs reduction by being stretched over the head, holding [illegible] down on the ventral aspect of the scapula; thus, relaxation of this muscle is necessary before reduction can take place. It is recommended that an anesthetic be given. Reduction is done in four steps.

Step 1. Bring the elbow into contact with the side of the thorax (Fig. [illegible]).

Step 2. Relax the subscapularis by rotating the arm with great care externally. Force should be applied very gradually. Bend the elbow and exert strong traction on the arm while rotating. (Fig. [illegible])

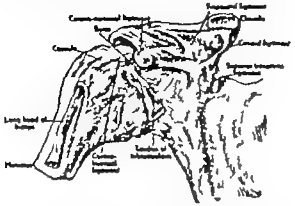


Fig. [illegible]. Right shoulder joint from in front (after [illegible]).

Step 3. Lever the head of the humerus down until it is directly opposite the lower part of the joint by bringing the elbow forward, inward and upward, at the same time continuing the external rotation at the shoulder and traction in the long axis of the humerus (Fig. [illegible]).

Step 4. Rotate the arm in, bringing it across the chest to the opposite axilla until the head of the humerus slips into the joint (Fig. [illegible]). This method is recommended by Kocher and requires no force at any time. However it may not succeed if the shoulder has been dislocated for several days. In that event reduction may be brought about by exerting traction on the arm at right angles to the trunk (Fig. [illegible]).

[illegible] an assistant exert countertraction by pulling on a folded sheet which has been placed around the upper part of the chest under the axilla. A second assistant exerts strong traction on the abducted arm while the surgeon moves the limb from side to side trying to get the head back in position.

Fig. [illegible]. Subcoracoid dislocation of humerus. [illegible] flattening of shoulder.

Fig. [illegible]. Subcoracoid [illegible] luxation of the humerus.

Some maintain that the method of directly pulling on the arm while the surgeon's foot is in the patient's axilla is contraindicated on account of the danger of injuring important nerves and blood vessels and possibly fracturing the [illegible]. This statement should, however, be qualified because experienced surgeons have for decades resorted to this, the Dupuy method of treating shoulder dislocations with excellent results. Judgment and systematic procedure are followed by good results here. I have made use of this method on numerous occasions with

Fig. [illegible]. [illegible] dislocation of the [illegible] humerus. [illegible]

gratifying results. In speaking of the Dupuy method Paul B. Magnuson states: "A considerable amount of force can be used without damage. The heel been used not only for countertraction but to push the head backward and upward toward the glenoid. In my experience this has been the most uniformly successful method." Figures [illegible] and [illegible] depict the procedure. The legends on the illustrations describe the steps.

A sling should support the arm for about 3 weeks, electrical treatments given the muscles and shoulder and movements begun. Full abduction of the shoulder should not be attempted before the expiration of three or four weeks.

Old shoulder joint dislocation may call for an open surgical operation on account of symptoms resulting from pressure on nerves or blood vessels and for functional as well as cosmetic improvement. The general intention of such opera-

tions is to restore the head of the humerus to its normal and permanent location. A number of different technics have been described.

Step 1. Make an anterior incision over the head of the humerus.

Step [illegible]. The conditions concerning or preventing the reinsertion of the head of the humerus in the glenoid cavity should be investigated, and from what he finds the surgeon must decide upon what method to follow in order to restore conditions to normal.

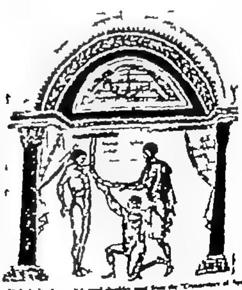


Fig. [illegible]. Method of reducing dislocated shoulder joint from the "Commentary of Apollonius of Kitium," [illegible].

Habitual and Recurring Dislocations of the Shoulder

While not common, this occurs frequently enough to interest the surgeon. The types of surgical interference for correcting this condition include operations upon the capsule, operations upon muscles and check ligaments, arthrodesis of the shoulder joint and bone transplants, the last method being probably the most satisfactory. The steps are as follows:

Step [illegible]. The deltoid muscle is partly cut through at about [illegible] cm. below its clavicular insertion.

Step [illegible]. The tip of the coracoid process is sawed off so as to lower the coraco-brachialis and pectoralis minor muscles.

Fig. 1007 Fig. 1008

Fig. 1007. Dislocation of the shoulder. Kocher method of reduction. Step [illegible]: bring the elbow into contact with the side of the thorax.

Fig. 1008. Dislocation of the shoulder. Kocher method of reduction. Step [illegible]: the forearm carried outward into the transverse axis of the thorax.

Fig. 1009 Fig. 1010

Fig. 1009. Dislocation of the shoulder. Kocher method of reduction. Step [illegible]: elevation of the elbow.

Fig. 1010. [illegible] of the humerus. Kocher method of reduction. Step [illegible]: inward rotation.

Step 3. Oudard placed a bone transplant, 3 to [illegible] cm. in length, on the anterior part of the joint between the base and sawed-off tip of the coracoid process

so as to oppose the tendency of the head of the humerus to forward projection. Eden placed the transplant underneath the raised periosteum of

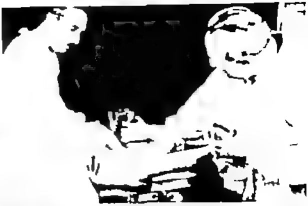


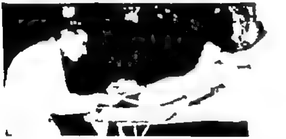
Fig. 1011. Dislocation of the humerus, reduction under anesthesia: surgeon attempting to return head [illegible] to the socket.

[illegible] 1012. Dowd method of reducing recent dislocations of the shoulder joint [illegible] [illegible]

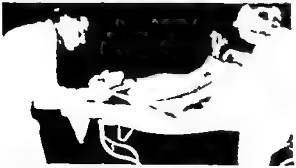
the neck of the scapula so that from 1½ to [illegible] cm. protruded in front of the joint.

Step 4. Closure of the wound.

In dislocations of the humerus complicated by fractures of the greater tuberosity or a portion thereof where [illegible] impossible to manipulate the head of the humerus to bring [illegible] into apposition with [illegible] fragment in the hope th[illegible]



[illegible]



[illegible]

open operation [illegible] indicated for its repair [illegible] or fixation. The operation described by Goldey L. McWhorter[illegible] an excellent procedure.

MCWHORTER'S OPERATION

Step 1. Make an incision along the lower border of the spine of the scapula and the acromion process (Fig. 1013 A). The lateral end of the incision

Surgical Clinics [illegible] [illegible], Oct., 1930.

extends rather sharply downward permitting adequate reduction of the deltoid muscle.

Step [illegible]. Divide and retract the skin and subcutaneous tissue. Expose the deltoid muscle and divide along the spine of the scapula leaving about [illegible] cm. of muscle attached to the bone (Fig. 1013 B). Retract the deltoid downward, thus exposing the posterior and lateral surfaces of the shoulder joint as well as the upper end of the humerus and bringing into full view the teres

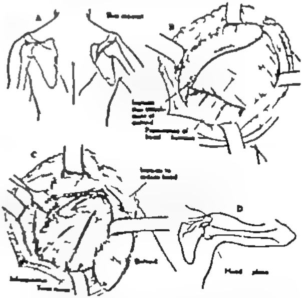


Fig. 1013. [illegible] McWhorter's operation for dislocation of the shoulder.

minor and infraspinatus muscles and their attachment to the fractured greater tuberosity of the humerus (Fig. 1013 C). If conditions are favorable the detached greater tuberosity may be reattached to its normal [illegible] or [illegible] may be removed and the tendon sutured to the humerus.

Step 3. Abduct and externally rotate the arm bringing the tendons of the supra- and infraspinatus muscles well over their original site on the humerus. [illegible] hole through the cortex of the humerus just below the point of fracture. Through the drill hole thus made chromic catgut is passed and [illegible] the tendons, the structures are firmly fixed in their original position (Fig. 1013 D). [illegible] holes may be dispensed [illegible] and mattress sutures.

Following the operation immobilize the arm in abduction and keep it splinted for about 3 weeks.

Kellogg Speed describes his method[1] of dealing with habitual dislocation of the shoulder as follows. An incision is made from just below the coracoid process straight down for about 4 inches and passing through skin, superficial tissues and fascia. The edge of the pectoralis major muscle is then identified at the lower angle of the incision. By blunt dissection the left index finger is pushed up under the muscle until its superior border is reached and at the point of junction with the deltoid the finger is hooked through and the muscle is cut transversely across its fibers for about 1½ inches from the tendinous insertion into the humerus. The axillary contents are exposed and the nerves and vessels placed out of the way; the edge of the glenoid fossa is palpated deep and brought into view.

A chisel is inserted into the scapula, just anterior to the glenoid edge, and a slot, 1½ inches deep, is formed in the scapula into which a bone transplant from the tibia may be driven leaving about ½ inch projecting anteriorly and obliquely across the lower anterior margin of the shoulder joint. The joint capsule is not necessarily opened. This procedure in no way interferes with the normal range of shoulder joint motion but it does prevent the head of the humerus from slipping forward in habitual dislocation.

CLAIRMONT'S OPERATION

Step 1. From the coracoid process, carry an incision outward and downward for six inches along the anterior border of the deltoid muscle. Carefully separate the deltoid fibers until the quadrilateral space is identified. Enlarge it by cutting the upper portion of the teres major.

Step 2. Palpate the posterior border of the deltoid and define its edge by four inch incision parallel to that in Step 1. Select a muscle bundle about one and one-half inches broad. Separate it from the main mass of the deltoid with great care. Detach it from its humeral insertion with a portion of adherent periosteum. Throughout these maneuvers have identified and protected the axillary nerves.

Step 3. Pass a forceps from before backward through the quadrilateral space; grasp and draw the deltoid muscle slip forward. Bring the muscle slip snugly beneath the head of the humerus and suture the tip containing the periosteum to the coracoid process. If the muscle is too short unite it with adjacent muscle structures (Fig. ...).

Step 4. Close the wound. Dress and immobilize the arm in 45 degrees of abduction in plaster of Paris airplane splint for about six weeks.

FASCIAL FIXATION OPERATION

This procedure is expedited by having two operating teams, one to supply fascia strip to be used for fixation, and the other to tie it in place.

A strip of fascia lata measuring ten by one half to three-quarters inches is removed and immediately utilized as follows.

Step 1. A four inch incision is made in line with the fibers of the deltoid muscle and one and one-half inches from its anterior border. The fibers are then carefully separated until the capsule of the humerus is exposed.

[1] Fractures and Dislocations, 3rd Ed., 1935.

Step 2. In similar manner a posterior incision is made and the capsule exposed.

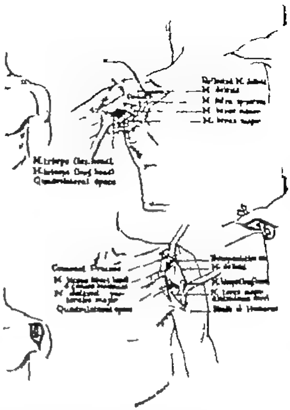


Fig. ... Clairmont operation for recurrent dislocation of the shoulder.

Step 3. Bring the forearm to a right angle with the shaft of the humerus which is abducted at 45 degrees and firmly held. Palpate the head of the humerus and pierce its upper pole from behind forward with a drill hole (Fig. ...).

Step 4. With a curved forceps form a subcutaneous tunnel from the upper limit

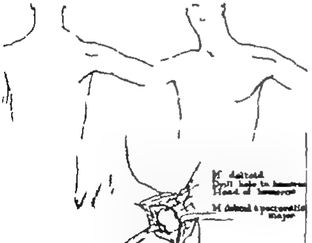


Fig. ... Fascial sling operation for recurrent shoulder dislocation. See text for description of steps.

of the posterior incision forward and over the acromion to the upper limit of the anterior incision. Roll the strip of fascia into a tubular form and pass it through the head of the humerus and thence over the acromion. Pull the sling thus created taut and very carefully suture the two ends.

Step 5. Close the wounds. Dress and place the arm in 45 degrees of abduction.

Commenting on the treatment of recurrent dislocation of the shoulder, G. E. Bennett[2] says that if the head of the humerus is to be prevented from slipping forward it must be stopped by a check ligament, transferred muscle or bony obstruction placed on the scapula anterior to the head of the humerus. Most cases need only a check which is equal to the tensile strength of the anterior part of the capsule of the joint which is usually the only damaged and weakened structure.

Bennett also stresses that "so many operations have been described to remedy this condition it is best for convenience' sake to group them as

1. those designed for the repair and reinforcement of the capsule (Thomas and Keller);

2. those in which a bone graft is used to act as an abutment to prevent the head of the humerus from passing forward (Eden and Speed);

3. those in which an attempt is made to establish a check ligament attached to the scapula and humerus in such a position that it is drawn taut when the arm is abducted and hyperextended. This form of surgical therapy embraces muscle-plastics, tenoplastics and free transplant of tendon and fascia (Joseph, Bach, Gallie, Löffler, Plummer and Pott, Wolfing, Eden, Carrel and Bennett). Since the introduction of fascia in the repair of relaxed structures, there has been a constantly increasing use of this material in the repair of the capsule and the construction of a check ligament that prevents the head of the humerus from slipping forward into a dislocation."

These operations have one pivotal point, viz., to attach the fascia to the acromion process of the scapula. The attachment to the humerus varies. Bennett used this procedure in 14 cases with apparent success.

BENNETT'S OPERATION

Step 1. Approach the shoulder joint through an anterior incision beginning at the acromion process and extending downward, dividing the fibers of the deltoid and exposing the anterior and inferior part of the capsule. Identify the long head of the biceps as a guide to the line of fascial sutures.

Step 2. Take a strip of fascia from the tensor fasciae femoris and fix it to the Gallie type of needle. Rotate the arm externally to allow suturing as far forward as possible. Insert the fascia into the capsule as shown in Fig. ...

Step 3. Draw the capsule taut (Fig. ...) and tie the fascia firmly to the capsule by chromic catgut sutures. Insert the fascia through the tip of the acromion process with a needle or by drilling a hole through the process and secure it here and to the anterior part of the capsule. It is usually brought lower than shown in the illustration.

This transplant and suture take up the slack from the anterior capsule and establish a ligament reaching from the acromion to the anterior capsule; the

[2] International Surgical Digest, Vol. ..., p. 70, February, ...

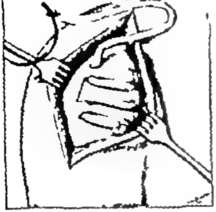


Fig. [illegible]. Bennett operation for the treatment of recurrent dislocation of the shoulder. Incisions [illegible]. (Courtesy Dr. G. E. Bennett and [illegible] F. Post Co.)

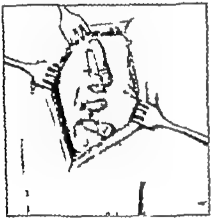


Fig. [illegible]. Bennett. [illegible] of recurrent dislocation of the shoulder. [illegible] (Courtesy Dr. [illegible] Bennett and [illegible] F. Post Co.)

subscapular tendon may be included. This reinforces the capsule and prevents anterior dislocation of the shoulder. Immobilize the arm in Velpeau type of bandage for four weeks, begin to use it gradually.

Comment. In a later communication Bennett summarizes his findings as follows:

"In cases of old dislocation of the shoulder operation is indicated for restoration of function and relief of discomfort.

"Operation is advised in all early cases. In the older cases, in which the shoulder has been dislocated for several months and there is painless adaptation with 90 degrees of free movement, operation is not advisable. Experience has shown that the end result in these cases is seldom perfect function of the shoulder with [illegible] free range of motion. [illegible] the free movement obtained is in proportion to the duration of the dislocation. The early cases are much more successful.

"Weakness of the deltoid is present in [illegible] large percentage of cases following operation. This may be due either to the original injury or to the operation, as the nerve supply to the deltoid may be easily damaged by the division of the subscapularis muscle.

"The first step in the operation, in the author's opinion, is the clearance of the glenoid fossa and the division of the subscapularis muscle, but the most difficult step is the reconstruction of the anterior portion of the capsule. This may be accomplished by utilizing the long head of the biceps, as described by Nicola [illegible] in his treatment for recurrent dislocations of the shoulder, or by reinforcing the anterior part of the capsule with fascial sutures. In one or two instances the author has transferred the tendon of the coracobrachialis and the long head of the biceps and attached them to the short anterior portion of the capsule, thus reinforcing the anterior part of the joint. While operation for an old dislocation of the shoulder may not result in 100 per cent function, it is much more satisfactory than resection of the head of the humerus for the same condition."

FRACTURES OF THE HUMERUS

Fractures of the humerus may be treated by the manipulative or open surgical method depending upon whether the fracture is simple or compound and upon several other factors. Generally, the manipulative method [illegible] preferred for uncomplicated fractures. In the Report of the Committee on Fractures of the American Surgical Association, published in [illegible] (p. [illegible]), it is stated that [illegible] per cent of the cases of simple fracture of the humerus reported upon were treated by the open operative method, indicating that anatomic reduction of these fractures without the assistance of vision directly upon the fragments is very difficult in [illegible] large number of cases. The Committee found that both in nonoperative and open operative methods when [illegible] good anatomic result was obtained [illegible] good functional result is likely to follow. This remark applies equally well to all other fractures besides that of the humerus.

Fracture of the Surgical Neck of the Humerus

Fracture of the surgical neck is [illegible] type of injury which may fail to be relieved by manipulative measures and open surgery is therefore indicated. These

The Journal of Bone and Joint Surgery, July, [illegible]

may be necessary for [illegible] long time after manipulative reduction and if the head of the humerus [illegible] dislocated [illegible] compress the axillary vessels or nerves (Figs. [illegible]). The general surgical procedure [illegible] as follows:

F[illegible] Drawing [illegible] fracture [illegible] surgical neck [illegible] humerus. After Farrell.

[illegible] surgical neck of humerus with marked anterior displacement.

Step [illegible]. A long anterior incision is made starting at the acromion [illegible] to expose the head of the humerus over the interval between the pectoral and deltoid muscles [illegible] in front of the acromioclavicular joint.

may be employed. The tendon of the pectoralis major is cut and the deltoid muscle is split. The circumflex nerve is located.

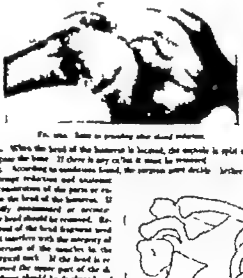


Fig. [illegible]. Same as preceding after closed reduction.

Step 2. When the head of the humerus is located, the capsule is split so as to expose the bone. If there is any callus it must be removed.

Step 3. According to conditions found, the surgeon must decide whether he will attempt reduction and anatomic reconstruction of the parts or excise the head of the humerus. If badly comminuted or avascular the head should be removed. Removal of the head fragment need not interfere with the integrity of insertion of the muscles in the surgical neck. If the head is removed the upper part of the diaphysis should be freshened and rounded off. If the fracture [illegible] very low the muscles may have to be reinserted in the surgical neck. The use of internal metal or bone splints is inadvisable in this type of injury. If the head [illegible] not removed attach it to the diaphysis [illegible] strong sutures.

F[illegible] [illegible] fracture of the surgical neck of the humerus [illegible]

Step 4. Closure of the external wound. Place the arm in [illegible] plaster cast and fix [illegible] in position of adduction close to the thorax [illegible] an axillary pad for 3 weeks.

The same type of operation app[illegible] to the dislocation of the head of humerus.

The nonsurgical treatment of fracture of the surg[illegible] neck of the [illegible] is depicted in Fig. [illegible].

Fractures of Upper End of the Humerus

These are not common. When such a fracture occurs, open surgical operation is recommended to prevent the head of the humerus from adhering to the surrounding tissues and to prevent the formation of a false or flail joint.

Step 1. A cross-bow incision is made about the acromion process half an inch below its border and a straight incision down the outer anterior aspect of the shoulder. The soft parts are retracted down to the bone.

Step [illegible]. The capsule is opened, the glenoid cavity and humerus are exposed and the fracture set. [illegible] Any loose bone fragments are removed; the

Fig. [illegible]. Fracture of the surgical neck of the humerus [illegible]. Patient [illegible] years of age. [illegible] weight [illegible] pull. [illegible] (Surgical Service Cook County Hospital.)

fragments are aligned in proper position and held by kangaroo tendon sutures, wiring or any other device the surgeon may select.

Step 3. Close the wound in layers. Place the arm and torso in a plaster cast for [illegible] months.

In the case of a severe fracture dislocation, arthrodesis at the shoulder joint may be the best procedure.

Separation of the Upper Epiphysis of the Humerus

Separation of the upper epiphysis of the humerus with pronounced dislocation of the fragments may require open surgical reduction and fixation in order to avoid permanent deformity and the formation of undesirable callus (Fig. [illegible]). The approach is the same as that described for fractures of the surgical neck of the humerus and nailing may be employed for fixation of the fragments.

In old standing cases of epiphyseal separation with malunion an open osteotomy and correction of the anatomic disposition of the parts will suffice, followed by putting the arm in a plaster cast for about three weeks.

Fracture of Shaft of Humerus

Open operative treatment of fractures of the shaft of the humerus is indicated in cases of persistent non-union or especially disfiguring malunion; also when the radial nerve has been involved either having been severed or caught between bone fragments or entangled in callus formation (Fig. [illegible]).

Step 1. The incision is made on the outer aspect of the arm, to avoid nerves and blood vessels, and is carried down to the bone carefully avoiding the radial nerve. The bone ends are exposed.

Step 2. The ends of the bone are bared in the usual way and brought into correct alignment. Although for osteosynthesis the Lane plate is very satisfactory in this fracture yet in old ununited fractures the use of an inlay or intramedullary placed bone graft or bone pegs (after the ends of the fracture

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Fracture of shaft of humerus.

Fig. [illegible]. Paralysis of the radial nerve owing to pressure of displaced fragments of the humerus.

fragments have been sawed off) may be more advantageous. Even if a bone graft be used, Lane plate can be employed as an internal splint.

Step 3. Close the wound. Maintain the position of the fragments and graft until good union has taken place. Immobilization of the arm is usually required for from 8 to 12 weeks by Buck's extension or airplane plaster of Paris cast with traction.

If the radial nerve has been involved, it must be freed from adhesions or callus (Figs. [illegible]). If a scar has formed in its continuity or if it has been pinched for some time it may be necessary to resect a part of the nerve. Some method of neuroplasty is usually called for in such cases.

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. X-ray [illegible] of patient shown in the preceding illustration.

Fig. [illegible]. Incision for the exposure of the radial nerve.

Fig. [illegible]. Fracture of the upper epiphysis of the humerus.

Separation of the Lower Epiphysis of the Humerus

is usually treated by manipulative methods, but, if these fail, open operation with lateral incisions and extension and fixation of the fragments suffice.

Fracture of the Greater Tuberosity of the Humerus

Fracture of the greater tuberosity of the humerus occurs either as a complication of a dislocation at the shoulder or as a result of trauma upon the tuberosity itself. When the greater tuberosity is fractured the fragments tend to remain attached to the humerus by periosteum and there are seldom wide separations, [illegible] the pull exerted by the posterior scapular muscles. Treatment: by

Fig. [illegible]. [illegible] fracture of the lower end of the humerus [illegible]. The upper fragment [illegible] to be displaced forward and the lower fragment with the olecranon displaced backward. The posterior displacement [illegible] by [illegible] of the triceps muscle. (From Davis' Applied Anatomy.)

placing the arm in full abduction and rotating [illegible] externally to 90°. In recent [illegible] dislocation of the shoulder complicating the injury [illegible] treated and the tuberosity fracture is also treated but may have to be disregarded. If after seven weeks the fragment is found to be displaced and producing untoward symptoms open surgical operation is indicated.

Step [illegible]. An incision is made over the injured tuberosity in the long axis of the injured limb. Avoid the adjacent nerves and blood vessels. Expose the fractured surfaces, freshen and return them to their normal position.

Step [illegible]. Nail or screw the fragments into the shaft of the humerus and reinforce them with a few of heavy chromic sutures. Close the wound.

Step 3. Put the arm in a molded plaster splint as previously described, for about [illegible] weeks.

Supracondylar Fracture of the Humerus

Like the foregoing, this fracture is difficult to reduce and maintain by manipulative methods (Fig. [illegible]). The line of fracture is usually from behind extending downward and forward. The short distal fragment is displaced backward and slightly upward and the long proximal fragment projects into the cubital space, occasionally injuring the ulnar or median nerve or neighboring blood vessels. When not surgically reduced, healing usually takes place with

Fig. [illegible]. Fracture of external condyle of humerus.

union of callus which seriously interferes with flexion of the arm and considerable deformity. Paralysis may appear late. Open surgical correction is the better way of dealing with such fractures. Or use skeletal traction through the proximal end of the ulna with the forearm in flexion supported by a Balkan frame.

Step. The fractured region is exposed by a medial incision along the inner side of the arm, about 3 inches above the elbow passing over the internal condyle and down the forearm for about 1½ inches. A flap is turned up which exposes the ulnar nerve which is dissected and retracted and the fracture then exposed and treated as indicated.

Step 2. The bone fragments are replaced in correct anatomic position and are wired or pegged; the elbow is put up in a position of extreme flexion (90-100°).

Step 3. The forearm and elbow are placed in a plaster cast for about [illegible] days before motion is started.

Fracture of the Internal Condyle of the Humerus

This fracture is rather rare and results from an upward displacing force being transmitted through the ulna to the internal condyle (Fig. [illegible]). Reduction is usually easily effected and a plaster cast maintains the forearm flexed 90 degrees at the elbow and rotated into full pronation. There is, however, a tendency for displacement to occur when the reducing force is removed. For this reason and because the ulnar nerve is frequently involved, open operation is often necessary.

Step. Expose the fracture through an incision along the inner side of the arm being careful not to injure the ulnar nerve.

Step. Examine the canal of the ulnar nerve—the nerve, if damaged is dissected free and transplanted to the front of the elbow.

Step 3. Reduce and nail, screw or suture the fractured condyle to its original location.

Step 4. After closing the wound, maintain the arm in the position previously described.

DISLOCATIONS AT THE ELBOW JOINT

Posterior dislocation is readily discerned on account of the backward projection of the olecranon process with the triceps inserted into it and of the articular surface of the humerus in front (Fig. [illegible]). Either or both bones may be dislocated either backward, forward or laterally. The usual one encountered most frequently, however, is that in which both bones are displaced backward.

Fig. [illegible]. Dislocation of the elbow.

If the ulna alone is dislocated, it is always displaced backward; the radius, more frequently forward. In case of dislocation of the ulna alone or both bones, reduction is brought about by flexing the arm around the knee of the operator. After the patient has been seated in a chair the surgeon places his foot on the seat and bends the elbow around his knee. In this way the coronoid process of the ulna is levered over the end of the articular surface of the humerus.

In case of dislocation of the radius alone, hold the arm above and below the elbow, straighten and bend it at a right angle. At the same time press the head of the bone into position.

Where muscular spasm is marked, administer a general anesthetic. Figures [illegible] depict the method of reduction of a backward dislocation of the elbow and that of the head of the radius.

After reduction has been accomplished, bandage the arm at right angles, keeping the hand midway between pronation and supination. In case the radius has been displaced, place a pad over its head to hold it in position. Begin passive movements in about 7 days.

FRACTURES OF THE OLECRANON

The most usual site of fracture of the olecranon is at its junction with the shaft of the ulna (Fig. [illegible]). The method of repair generally is by suturing or wiring, but special methods such as bone inlay may be employed.

Fig. [illegible]. Backward dislocation of the elbow.

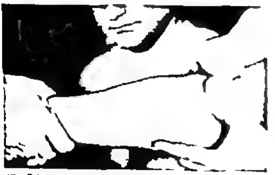


Fig. [illegible]. Dislocation of the head of the radius, which is reduced by traction of forearm and direct pressure on the head of the radius.

Step. Either an oval incision is made with its convexity upward passing around the olecranon or a median longitudinal incision beginning and ending considerably above and below the line of fracture but not involving the tissues above or below. The incision is carried down to the bone.

Step 2. The procedures here—exposing the fractured ends of bone, drilling the two fragments, passing and tightening of the wire, suturing the torn periosteum and fascia and closure of the wound—are identical with the method of dealing with a fractured patella by suturing or wiring.

Step 3. The limb is put up in full extension supplemented by anterior plaster of Paris cast.

If the fracture is compound, if there is considerable effusion of blood and if the proximal fragment is retracted very much and is very mobile, the following surgical treatment is indicated.

Step. The fracture fragments are exposed by cutting and turning up a U-shaped flap or by a transverse incision or by enlarging the wound in case of a compound fracture. If a transverse incision is employed, it is placed a little above or below the line of fracture.

Step. Cleanse the whole fracture area and excise any ragged ends of splintered bone.

Step 3. The continuity of the bony parts is reëstablished by drilling, wiring, or other selected osteosynthetic procedure, the periosteum being first dissected back for a few centimeters from the fractured bone ends.

Step 4. The fibroperiosteal tissues are again united over the fractured area and the external wound closed.

Step 5. The elbow is kept elevated and in full extension. Put up in anterior splint. Movements of flexion and extension should be begun as soon as possible.

Fig. [illegible]. Fracture of the olecranon process of the ulna.

FRACTURE OF CORONOID PROCESS OF THE ULNA

This fracture is usually associated with posterior dislocation of the elbow. Old cases causing interference with flexion should be surgically treated.

Step. A lateral incision is made in front of the condyles of the humerus. The muscles are separated from the anterior surface of the condyles and the brachialis anticus and coronoid process are exposed.

Step. The disability is usually due to excessive callus formation or formation of bone in the tendon of the brachialis anticus. They should be removed and the tissues restored as far as possible to normal condition.

Step 3. Close the wound. Dress and apply a sling. Passive and active movements should be begun early.

FRACTURES OF THE BONES OF THE FOREARM

Generally speaking, open surgical treatment of fractures of the bones of forearm is only rarely indicated and manipulative methods are the [illegible]

better results (Figs. [illegible]). The Committee on Fractures of the American Surgical Association in its Report issued in 1933, states that these fractures treated nonoperatively gave good functional results in [illegible] per cent of the cases as compared with 66 per cent of those treated by open operation. Furthermore the nonoperated cases showed only [illegible] per cent of bad functional results as compared with [illegible] per cent in the operated cases. However it should be taken into account that the surgically operated cases in the main were those in which injury was most extensive and delay in adequate treatment most pronounced. Figure [illegible] shows the method of reducing fracture of the forearm (reduction by traction and manipulation followed by immobilization).

Fig. [illegible]. Fracture of radius and ulna.

In open fractures of one or both bones of the forearm, the general surgical treatment is that of all other open fractures, namely exposure of the fragments, uniting them by one of the ordinary osteosynthetic methods, removing bone fragments, cleansing the area and closure of the wound.

There are, however, several cardinal points which should be borne in mind. Do not hesitate to make two incisions for the exposure of the two bones but do as little sharp dissecting as possible. Before employing pegs or plates for reduction endeavor to draw the fragments into position by tying around them with chromic gut or kangaroo tendon, or by pulling them together with gut passed through drill holes in the bone. Do not close the wounds until both bones are in place.

Preserve this relationship by continuous traction during closure and dressing (Figs. [illegible]).

Colles' Fracture

This fracture is caused by falling on the outstretched hand. The line of fracture occurs in the distal part of the radius; however usually there is no involvement of the wrist joint. The distal portion is forced backward and upward; at the same time it leans toward the radial side causing the articular surface to face downward, backward and outward. Displacement of the lower fragment includes the hand and carpus. The fragments are very often impacted. Frequently the internal lateral ligament of the wrist is torn or the styloid process of the ulna is torn off (Fig. [illegible]).

Treatment

An anesthetic is commonly used during the correction of this deformity.

Step 1. Grasp the patient's hand (as for the salutation of "shaking hands"); if the fracture is on the right side, use your right hand; if on the left side the left. Disimpact and make longitudinal traction, keeping in mind the direction of the displacement. An assistant grasps the elbow and makes countertraction.

Step 2. Fix the fracture area with the free hand and press the displaced lower portion into position with the thumb, finally replacing the radius by wrenching the hand into a position of ulnar adduction.

Step 3. Secure the hand in position by means of a Carr splint (Fig. [illegible]). The Carr splint may be modified as follows to increase its efficiency: (a)

Fig. [illegible]. Comminuted splintering fracture of radius and ulna with exposure of the splintered bone.

A broader posterior splint may be substituted for the usual one which is frequently too narrow; (b) A pad placed over the fractured area and one under

Fig. [illegible]. Method of reducing fracture of the forearm.

it will assist in keeping it in place. (c) There is likely to result an unpleasant swelling of the fingers if the splints are applied too tightly.

ROBERT JONES' METHOD

In the more complicated types of Colles' fracture, Sir Robert Jones' method should be used.

Step 1. Take the patient's forearm in the left hand while your right hand is placed on the back of the patient's wrist (Fig. [illegible]). While firmly gripping the wrist, slightly pull and twist it, reducing the fracture.

Step [illegible]. Place a wool pad over the lower end of the upper fragment in front, and over the small lower portion in back. Secure these with metal splints, giving them a slight spiral twist. The metal splints are strapped and the forearm is placed in a sling (Fig. [illegible]).

Fig. [illegible]. Fig. [illegible].

Fig. [illegible]. Method of treatment of fractured radius and ulna shown in Fig. [illegible].

Fig. [illegible]. Fracture of radius and ulna (middle [illegible]) in [illegible] [illegible] years of age. Double [illegible] fracture. In two [illegible] with [illegible] plaster of Paris cast [illegible] applied to the middle third of the forearm. [illegible] Service, Cook County Hospital.

If a Colles' fracture is properly treated, it should never cause trouble. Care should be exercised so as not to strain the newly formed callus which is likely to result in a stiff and painful wrist. The splints are kept on for three weeks during which time light exercise of the fingers is advised. Massage is more beneficial after the fracture has united.

Comment. Colles' fractures are best treated by: a, disimpaction by extension; b, application of traction; c, flexion at wrist; and d, pronation of distal fragment, followed by e, immobilization in plaster of Paris dressing.

DISLOCATIONS AND FRACTURES OF THE WRIST BONES

Although these are almost always treated by manipulative methods, yet persistent dislocations, persistent stiffness, pain and loss of function occasionally need open surgical correction (Figs. [illegible]).

Fig. [illegible]. Colles' fracture.

Fig. [illegible]. Carr [illegible] splint [illegible] Colles' fracture.

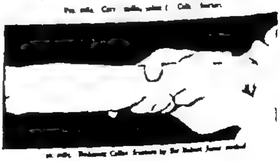


Fig. [illegible]. Reducing Colles' fracture by Sir Robert Jones' method.

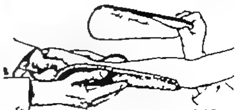


Fig. [illegible]. Sir Robert Jones' method of splinting Colles' fracture.

Dislocation of the semilunar (Figs. [illegible])
Backward dislocation of the distal row of carpal bones on the proximal row

Manipulative Treatment

Dislocation of the semilunar. Here the bone is usually dislocated forward and is felt as a hard lump underneath the flexor tendons. Flexion is limited and there is frequent involvement of the median nerve (paresthesia in the palm and fingers along the distribution of the nerve). X-ray diagnosis is not always satisfactory and is often misinterpreted. If attempts at reduction by manipulative methods fail, the semilunar should be removed (Figs. [illegible]).

Fig. [illegible]. Normal wrist joint.

Reduction is accomplished by (a) dorsal flexion of the hand, (b) direct pressure by the surgeon's thumbs on the anterior surface of the wrist, over the dislocated semilunar bone and (c) flexion of the wrist. This will usually result in the replacement of the dislocated semilunar bone. Keep immobilized in plaster of Paris dressing in full flexion for 4 days, followed by partial flexion for 6 days, after which, begin physical therapeutic measures.

Backward dislocation of the carpus. The diagnosis is difficult. The distal row of carpal bones projects backward. Swelling takes place and motion is impaired. Reduction soon after the injury is not difficult. It is effected by direct pressure forward on the distal row of carpal bones while an assistant makes long axis traction. If reduction fails, open operation comes into consideration.

Surgical Treatment

Step 1. An incision about 1½ inches long is made on the dorsum of the wrist or a [illegible] inch incision on the volar side of the wrist, according to the nature of the displacement of the wrist bone to be removed. The incision passes over the bone to be removed and slightly above the lower end of the radius.

Step 2. Tendons and nerves are retracted, the articular ligaments incised and the affected bone, lunar capsule or navicular usually, either one or more removed in fragments. The greatest difficulty lies in removing the distal fragments and separating them from their ligaments. Care must be taken not to bruise neighboring intact bones or their cartilage. When the fragments are removed the area is thoroughly cleansed and put in the best anatomic position.

Step 3. The wound is closed in layers. No splinting is necessary. Active movements may be begun after [illegible] week.

Comment. Open surgical treatment is indicated when the fracture is accompanied by much dislocation, when there is pseudarthrosis after manipulative treatment, with absorption of bone, persistent pain, stiffened wrist and restricted function.

Open surgical treatment can be classed under four heads: (a) drilling;

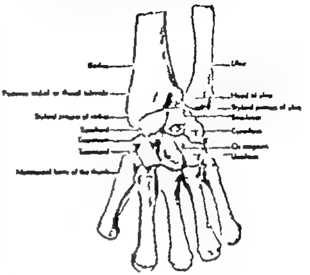


Fig. [illegible]. Palmar view of the lower end of the radius and ulna and the carpal bones. (From Davis, Applied Anatomy.)

(b) drilling followed by bone grafting; (c) obtaining fusion with neighboring bones; (d) excision of the affected bone.

If fusion is the method employed it must not be to the radius as that would ankylose the radiocarpal joint; the fusion should be with the lunar or capitate bones preferably.

Cave says: Our end-results from the bone graft operation have been very gratifying so far as the clinical aspects are concerned, but bony union occurred in only 4 of 7 cases (57 per cent). All 7 cases were rendered symptom free by the operation and anatomically and functionally are almost perfect.

Of carpal bone dislocations, that of the os magnum with complete separation of the semilunar bone following a fall on the extended hand is the most common type demanding surgical intervention. Figs. [illegible] depict manipulative treatment of dislocation of the os magnum.

Step 1. The anterior carpal surface is exposed by a longitudinal incision over the front of the wrist [illegible] to the inner border of the palmaris longus; the flexor tendons are retracted.

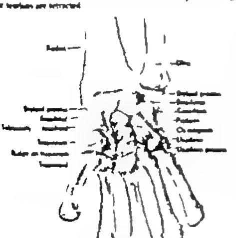


Fig. [illegible]. Anterior view of the lower ends of the radius and ulna and the carpal bones. [illegible] Applied Anatomy.

Step 2. The prominence formed by the displaced semilunar bone is exposed and the semilunar bone ligaments are separated; the proximal covering of the bone is [illegible] observed.

Step 3. The semilunar bone is removed as well as any fragments of [illegible] or other bones as necessary. The soft parts are replaced, the wound closed and movements of the hand begun at an early date.

DISLOCATION OF THE THUMB

The three types of thumb dislocation are referred to as complete, incomplete and complex. The dislocation is complete [illegible] the glenoid ligament rests vertically on the dorsum of the metacarpal [illegible] incomplete if the glenoid ligament and sesamoids still rest on the head of the metacarpal bone [illegible] is complex if the phalanx [illegible] placed straight and the glenoid ligament is inserted between the dorsum of the metacarpal and the dislocated bone (Fig. [illegible]).

Complete Dislocation

Flexion should not be used.

Fig. [illegible]. [illegible]. Fig. [illegible]. [illegible]

Fig. [illegible]. Reduction of dislocation of the os [illegible] of the [illegible] joint. [illegible]
Fig. [illegible]. Reduction of dislocation. [illegible]

Step 1. Place the patient's hand in [illegible] position.

Step 2. Grasp the thumb in the whole hand, push it further back and [illegible] the end touching the metacarpal obliquely forward and downward; the dislocated end should always precede and be kept close to the metacarpal bone.

Step 3. Reduction takes place when the glenoid ligament passes the border of the articular surface.

Incomplete Dislocation of the Thumb

Avoid flexion here also.

Step 1. Grasp the dislocated thumb firmly. Elevate it and supply traction and extension. Bend the thumb further backward.

Fig. 1042. Dorsal luxation of the proximal phalanx of the thumb: diversion of the tendons of the abductor and flexor brevis pollicis muscles. (From Dorn. Appl. of Anatomy.)

Step [illegible]. Push its upper end forward and downward. Reduction follows in the path of dislocation.

Fig. 1043. Farabeuf method of reduction of a complete dislocation of the thumb. Step [illegible]. Traction in the long axis of the thumb until its natural length [illegible] restored.

Complex Dislocation

Anesthetize the patient if it is deemed advisable.

Step 1. Stretch the thumb lengthwise until its normal length [illegible] restored (Fig. 1043).

Step 2. Elevate the thumb, at the same time forcing it backward until it is vertical to the metacarpal (Fig. 1044).

Fig. 1044. Farabeuf method of reduction of complete dislocation of the thumb. Step [illegible]. [illegible]

Fig. 1045. [illegible] method of reduction of complete dislocation of the thumb. Step 3. [illegible]

Step 3. While maintaining the thumb in perpendicular position, force it distally along the back surface of the metacarpal against which the base of the phalanx is pressed (Fig. 1045).

Step 4. Force it distally as far as possible, then [illegible], avoiding sudden flexion. Push the first phalanx forward and downward with the thumb.

Farabeuf forceps are very useful where the thumb is short and swollen. Figure 1046 illustrates how it is used. Observe how the phalanx is placed at right angles to the metacarpal. It is during this maneuver that the sesamoid bones and glenoid ligament are freed. If the forcing forward is begun too soon or if [illegible] is incomplete there will be no reduction. Great care should be exercised in carrying out the procedure and if failure results the first time, try [illegible] over two or three times. However, do not be too persistent and under no circumstances [illegible]

Fig. 1046. The use of Farabeuf forceps in reducing any variety [illegible] dislocation of the thumb.

[illegible] knife and bluntly incise everything which appears to obstruct reduction. Farabeuf and Vernand both recommend at this point dorsal arthrotomy and open section of the glenoid ligament. This is carried out as follows:

Step [illegible]. Disinfect the skin. Make an incision about an inch long on one side of the extensor tendon immediately over the dislocation. Divide the subcutaneous tissue.

Step 2. Draw back the extensor tendon and margins of the wound thus exposing the [illegible] of the luxation, the dorsal end of the phalanx and the back of the metacarpal bone [illegible] is covered by the glenoid ligament.

Step 3. Divide the ligament longitudinally in the midline, cutting down to the metacarpal bone and to the articular surface of the phalanx. In some in-

stances, it may be necessary to make two small transverse incisions in addition to the above.

Step 4. Pull and bend the thumb. Reduction should follow easily.

If, however, reduction does not take place, remove [illegible] wedge-shaped piece of the central portion of the glenoid ligament between the two sesamoid bones; then while stretching the thumb longitudinally, carefully insert an elevator from above down between the two bones. Lever the metacarpal into place with the elevator while bending the thumb.

In cases [illegible] complete reduction [illegible] impossible, it may be necessary to remove the head of the metacarpal.

This has given satisfaction in several instances. [illegible] has been followed by the proper [illegible]-treatment.

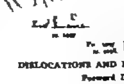


Fig. 1047

Fig. 1048

Fig. 1047. Fractures of the metacarpal bones.
Fig. 1048. Fracture-dislocation of the thumb.

DISLOCATIONS AND FRACTURES OF THE METACARPALS

Forward Dislocations of Metacarpals

Step [illegible]. Have an assistant draw back the finger.

Step [illegible]. Exert pressure on the dislocated phalanx with the thumb at the same time pulling the head of the metacarpal bone in the opposite direction with the fingers.

It is advisable to carry out this procedure under general anesthesia.

Fractures of the Metacarpal Bones

These fractures usually follow direct trauma, are oblique in type and involve most frequently the third and fourth metacarpal bones. The displacement usually [illegible]. The deformity and treatment [illegible] illustrated in Figs. 1047 and 1048.

Dislocations of the Fingers

These are treated much the same as dislocated thumb. Never bend the finger; stretch it longitudinally first, then stretch it backward, pressing the dis-

[illegible] Fracture of the metacarpal [illegible] the [illegible] produced by the [illegible] and the [illegible] of the [illegible] [illegible] and [illegible]. After [illegible].

located end against the back of the metacarpal so that it returns the way it became dislocated, forcing the glenoid ligament before it.

[illegible] Dislocation of proximal phalanx.

In cases which do not respond to the usual treatment open section is resorted to or subcutaneous division is carried out as follows:

Step 1. Make [illegible] puncture in the skin half an inch behind the phalanx base, near the outside of the extensor tendon, with [illegible] tenotome.

Step [illegible] Hold the handle of the instrument parallel to the tendon and insert the point under the skin [illegible] and the articular surface of the phalanx.

Step 3. When the point reaches the articular surface, raise the handle, thus depressing the point and directing it against the palmar ligament appearing on the dorsum of the metacarpal.

Step [illegible] Divide the ligament by pressing the point of the tenotome against the posterior surface of the metacarpal and drawing [illegible] backward for about one-third of an inch.

Dislocated phalanges (Fig. [illegible]) are usually successfully reduced by combining traction and direct pressure. Fig. [illegible] illustrates this procedure. An assistant pulls the finger [illegible] the surgeon holds the phalanx with index fingers crossed below and thumbs above and exerts pressure on the dislocated region.

Fig. [illegible] Reduction of [illegible] dorsal dislocation of the terminal phalanx of the index finger.

Fractures of the Phalanges

These are very common fractures, and although not considered serious are often difficult to treat (Fig. [illegible]). This [illegible] especially true of fractures through the base of the phalanges. The reduction of such fractures is illustrated in Fig. [illegible]. There are many traction and splinting methods designed especially for these injuries.

Fig. [illegible] [illegible] fracture of proximal phalanx of index finger.

FRACTURES OF THE THORAX

RIBS

Simple rib fractures may be treated by [illegible] and [illegible] (Figs. [illegible]). Complete open fracture of the ribs is uncommon. If the skin is opened it is generally caused by the object that causes the injury and by the fractured bone ends. The fractured bone ends may however penetrate the pleura or lung or [illegible] depressed rib fragment may cause the pleura or lung to split. The nerves or the intercostal artery may be involved (see Surgery of the Chest). When there is [illegible] lung puncture emphysema and pneumothorax may result. A compound fracture, or [illegible] simple fracture with hemorrhage from the intercostal vessels or lung, will be open surgical operation.

Step 1. An incision is made in the intercostal space over the fracture site. The

superficial tissues are dissected and search is made for any bleeding vessel [illegible] [illegible] ligated.

Step [illegible] It may be necessary to resect part of the fractured rib or ribs. If the lung is lacerated and bleeding, the ribs and parietal pleura in the vicinity are divided until there [illegible] space enough to draw the lung [illegible] forceps and pull it

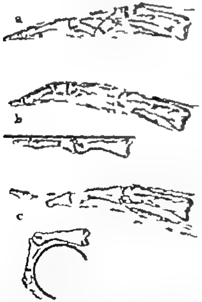


Fig. [illegible] [illegible] the proximal phalanx with the deformity produced by the pull of the [illegible] muscle. [illegible] the [illegible] produced by the flexor [illegible] and the resulting deformity corrected by [illegible] dorsal splint. [illegible] the middle phalanx distal to the flexor insertion and the resulting deformity corrected by [illegible] curved palmar splint.

into the wound opening. The lacerations are then sutured with catgut, anatomic conditions are restored as far as possible and the chest closed without drainage.

In an old thoracic cage fracture if the symptoms suggest that the intercostal nerve is pinched or involved in callus, or if necrosis of the injured bone is suspected, the callus must be removed and dead bone cut away.

In severe crushing injuries, such as those following automobile accidents, with increasing, spreading emphysema, multiple incisions are made through the

skin and fascia to allow the escape of air. If this is not sufficient [illegible] thoracotomy may be necessary.

STERNUM

In fractures of the sternum when ordinary manipulative reduction and retention methods fail and there is marked deformity an open surgical operation is indicated.

Step [illegible] A curved incision along the outer border of the sternum permits the reflection of [illegible] flap down to the bone.

Fig. [illegible] Palpating the chest wall for fractured ribs.

Step 2. The costochondral junctions from the first to the sixth may be resected in order to permit the sternum being raised up and levered into [illegible] correct anatomic position. A grooved director or periosteotome may be employed as [illegible] lever to lift the bone. Any deformities on the bone are then chiseled off.

Step 3. The flap is returned to place and sutured and maintenance is effected by suitable bandaging or retraction of the shoulders.

DISLOCATIONS AND FRACTURES OF THE SPINE

DISLOCATION OF THE VERTEBRAE

Dislocation of the [illegible] vertebrae is rare and was thought, at one time, to be impossible except as [illegible] complication of fracture. It is essential but difficult to distinguish between cases in which displacement is the result and those in which the fracture is an insignificant (Figs. [illegible]).

Non-Surgical Reduction of Cervical Vertebra

Attention should be given to proper reduction of the dislocation and to fixation. An anesthetic should be administered cautiously so that the relaxation resulting will not result in sudden movement of the head which is held in traction by the surgeon while the anesthetic is being given.

Spontaneous reduction quickly follows relaxation in many cases of distorsion and partial dislocation. The special treatment consists of reduction, fixation and methods employed to correct the injuries sustained. If reduction is advisable it should be attempted promptly although success has followed reductions which were made from one week to two months following the accident. It should be borne in mind that attempts at reduction are accompanied by danger from pressure on the cord and may result in death, therefore, diagnosis should be carefully made. If reduction is impossible and surgery is contraindicated, immobilization is indicated so that necessary repair may be assured.

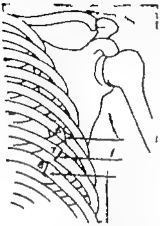


Fig. 1105. Transverse fracture of sixth, seventh and eighth ribs. Reconstructed from x-ray.

When the occiput is dislocated, steady firm traction on the head accompanied by direction pressure and forward or backward movements of the head, are indicated; in complete dislocation, extension and rotation of the head toward the dislocated side in unilateral displacement, affords a satisfactory method of restoration.

In dislocation of the atlas, great caution should accompany any manipulations.

In bilateral dislocation, steady firm traction in the line of the axis of the upper segment should be made while the neck is held rigid with the hands. Manipulations, if employed, should be made cautiously and with a clear knowledge of their dangers.

In cases of unilateral dislocation, the head is rotated to the sound side while extension is made; it is returned to its normal position afterward.

When the lower six cervical vertebrae are dislocated, the type of manipulation depends on the type of displacement. In case of subluxation, follow lateral flexion by slight rotation toward the dislocated side with lessening abduction. Failure of the attempt should be followed by repetition, cautiously increasing the force.

In cases of complete unilateral dislocation, Kocher recommends stretching the ligaments of the affected side by increasing the lateral deflection and simultaneously employing slow traction and rotation toward the involved joint. Rotation toward the sound side disengages the articular processes of the opposite side while abduction to the sound side with rotation toward the unsound causes the displaced articular process into correct position. In cases of bilateral complete dislocations, reduce first one side and then the other in accordance with the above suggestions. Keep in mind that rotation of the spine above the point of injury should be made by grasping the upper segment and not by turning the head. After reduction is accomplished, the head is supported and fixed in position with the aid of an apparatus maintaining occipito-mental traction or a high plaster-of-Paris yoke and collar may be worn from three weeks to two months.

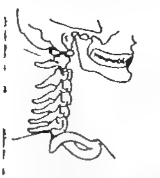


Fig. 1106

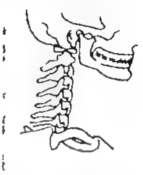


Fig. 1107

Fig. 1106. Dislocation of cervical spine, before reduction. Observe dislocation of spine and [illegible] between [illegible] and the third cervical vertebra. Reconstructed from x-ray.
Fig. 1107. Dislocation of cervical spine, after reduction. Note straight line. Reconstructed from x-ray.

With the best of mechanical treatment, these dislocations are likely to heal with some slight imperfection of a fractured process or malposition in the case of union of a torn ligament, which results in limitation of movements.

The degree of primary injury and extent of displacement govern the amount of damage suffered by the cord. The usual causes of dislocation are forcible flexion of the spine and direct violence due to moving vehicles and other heavy objects. Loss of power and deformity may result from injury or compression of the spinal cord which will be revealed by careful examination. If fracture is present, prominent bony points and movable fragments may be detected. In the presence of thin abdominal walls, irregularity of the surface of the bodies of the lower vertebrae may be noted. Dislocation and fracture symptoms are so similar that definite diagnosis without the assistance of operation or autopsy is uncertain, hence the term "fracture-dislocation." Nonsurgical treatment begins and ends with the advantages gained from extension and counterextension, accompanied by manipulation directed accurately to adjustment of the vertebral bodies when advisable.

The patient should be placed in a recumbent position with immobilization by plaster of Paris or similar material. Strict attention should be paid to personal hygiene.

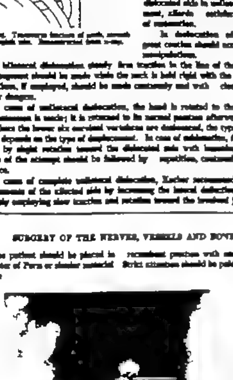


Fig. 1108. Forward dislocation of vertebra.

Fig. 1109. Fractured spine. Arrow points to fractured vertebra.

Dislocation of a lumbar vertebra is uncommon. In the few cases recorded force caused grave injuries to the vertebrae accompanied by displacement of the bodies of the bones. The symptoms are not clear cut and are not the same as those which accompany injury of the cord. Local deformity and tenderness associated with bony irregularities of the vertebral bodies may be ascertained by careful examination.

Reduction of backward dislocation may be accomplished by direct pressure on the spinous process, with extension and counterextension of the spine. In forward dislocation extension and counterextension accompanied by pressure in front may be effective.

Upper Cervical Vertebrae

SURGICAL REDUCTION

Open operation is indicated when reduction is difficult or when there is much pain.

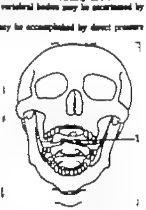


Fig. 1110. Passage of the [illegible] in reduction of the atlas and the axis. Reconstructed from x-ray. [illegible]

Step 1. A six-inch incision is made over the suboccipital space, the knobbed spine of the axis identified and the forwardly dislocated arch of the atlas exposed.

Step 2. Strong silk sutures are passed through the arch of the atlas taking care to avoid injury to the spinal cord. Finger pressure is made on the anterior arch until reduction is effected.

Step 3. The reduction is maintained by passing a silk ligature around the spine of the axis. A plaster cast is applied for at least 4 months.

If reduction is impossible by this method a laminectomy may be called for.

FRACTURE-DISLOCATIONS OF THE DORSAL SPINE

These are usually reduced by manipulative methods accompanied by hyperextension.

FRACTURES OF THE LUMBAR VERTEBRAE

The time and method of surgical operation will depend upon the nature of the injury and whether or not there are symptoms pointing to involvement of the spinal cord.

The main point to be considered by the operating surgeon is whether or not the spinal cord is injured. In crushing injuries, it may be as well to delay operative measures for a while to watch the course of events and to decide upon laminectomy only when the symptoms demand it. A late laminectomy will avoid adding operative shock to the traumatic shock because vertebral fractures of themselves do not usually call for immediate intervention. If the patient is not improved by manipulative reduction in hyperextension, and if there is a rising temperature and increasing pressure symptoms which threaten life, then operation by the open method is mandatory. (See laminectomy.)

The Technic of Ambulatory Treatment of Fractures of the Spine[1]

Step 1. Reduction is done as soon as the condition of the patient permits. One-fourth gr. morphine and 1/100 gr. scopolamine is given one hour before reduction is to take place.

Step 2. The patient is placed upon the table face downward and anesthesia is induced by either nitrous oxide or ethylene. When the patient is anesthetized, reduction of the fracture is done. Disappearance of the pre-existent kyphosis or the cracking sound produced by the disimpaction of the fracture signifies the accomplishment of the reduction.

Step 3. As soon as reduction has been achieved, the anesthetic is stopped and body cast applied.

Step 4. The patient is now turned on his back with two pillows under the curvature of the spine and permitted to remain in this position for at least five hours. A small window is cut in the epigastric portion of the cast.

Step 5. Twenty four hours later the cast is cut where desired and the patient permitted to be ambulant.

Step 6. As soon as the cast is satisfactorily trimmed, the patient is permitted to walk about.

Step 7. Graduated exercises are next given, the patient remaining ambulant, while still wearing the cast, for about four to four and one-half months, depending on existing circumstances.

Step 8. Finally physiotherapy is resorted to and the patient is permitted to resume his work at the end of eight or more months.

DISLOCATIONS AND FRACTURES OF THE COCCYX

These result from the patient falling with great force in a sitting position or in any manner that brings the coccyx suddenly and forcefully in contact with a hard substance. Dislocation results more frequently than fracture; the latter frequently occurs at the junction of the sacrum and coccyx. The injury, although very painful, frequently fails to manifest [illegible].

Reduction

The fragments should be replaced as soon as possible after diagnosis has been made. This is done by placing the index finger in the rectum and with the assistance of the thumb placing the fragments in their usual position. Anesthesia may be required. The buttocks should be tightly cross strapped and the patient should rest in bed for two or three weeks. Opium suppositories should be administered and heat applied locally.

Pain is sometimes felt for two or three months due probably to the contusion of the coccygeal plexus and sacrococcygeal sprain. If this persists coccygectomy is indicated.

Coccygectomy

Step 1. Make a small vertical incision over the articulation point of the sacrum and coccyx.

Step 2. Separate the articulating surface of the coccyx and holding it firmly free it to its tip by sharp dissection.

[1] As practiced by Drs. Wm. R. Cubbins and Carlo S. Scuderi at the Cook County Hospital.

Step 3. Round and smooth the end of the exposed sacrum and close the wound. Carefully avoid injuring the rectum.

FRACTURES OF THE HEAD

FRACTURES OF THE SKULL

(See also chapter on Skull Fractures)

These comprise about 5 per cent of all fractures and derive their importance from the possibility of injury to the brain. The mortality in cases of intracranial injury may vary from 20 to 50 per cent. Even with a comparatively mild bone injury, brain injury may be fatal.

Open surgical treatment of skull fractures depends upon the nature of the brain tissue pathology. In cases with little or no shock, open treatment may be promptly indicated. In a comminuted fracture when there is evidence of marked cerebral or dural hemorrhage, if other conditions permit, and if shock has subsided, the indication is for open surgical treatment; but this should usually not be attempted in the presence of great shock, rapid pulse and profound unconsciousness.

In the case of a linear fracture, with a hematoma beneath the scalp in the region of evident contusion, the surgeon must use his judgement in regard to opening up the area. The actual bone fracture is of little consequence in itself.

Unlike fractures elsewhere, the cranial bones are not subject to displacement; there is no muscle pull and the fracture, if there is no brain injury, usually unites.

Penetrating fractures of the cranial vault with depression of bone, hemorrhage from within the skull or with the presence of brain tissue in the wound, calls for immediate surgical treatment, if the patient's condition permits it.

In nonpenetrating injuries or comminuted fractures accompanied or not by scalp wounds the indications for craniotomy must be clear with a leaning toward conservatism. An indication for open surgical treatment is given by evidence of increasing intracranial pressure due to accumulation of blood from injured cerebral vessels, or from extradural meningeal irritation or edema of the brain. Meningeal infection, manifested by a spinal fluid containing pus and under increased pressure, is an indication for surgical operation. Generally speaking, craniotomy for exploration is indicated in all extensive, open fractures of the skull or when the signs of increasing intracranial pressure threaten life.

For technic of decompression see pp. 228-230 in chapter 6 on Skull Fractures.

DISLOCATIONS AND FRACTURES OF THE FACIAL BONES

In the case of an accident with much nasal bone injury, the general surgeon generally limits his efforts to elevating depressed bones with replacement of fragments maintaining them in place by packing the nares with gauze. External splints to correct lateral angulation have little value.

Fracture of the Nose

Fracture of the nose is characterized by trauma, epistaxis, swelling, redness, deformity and painfulness. Crepitation is also a symptom which is best determined by the surgeon holding the patient's head against his chest and determin-

ing by lateral manipulation whether there is any abnormal mobility or crepitation (Fig. [illegible]).

TREATMENT FOR SIMPLE FRACTURE

The air passages should be kept very clean and a nasal splint introduced into each nostril to act as a support and also for breathing purposes. Internal fixation is best accomplished by inserting a curved, perforated rubber splint for this purpose and leaving it in place for about two weeks.

Externally the nose may not appear the same as before the accident but if the air passages are kept clean and clear the reduction is considered success.

TREATMENT FOR COMPOUND FRACTURE OF THE NOSE

Compound fractures are comparatively rare and are usually the result of direct violence. The treatment consists in clipping off the tags of injured tissue and applying an antiseptic solution such as mercurochrome or iodine. Follow this procedure with the same treatment as is given in the case of simple fracture. Suture the skin edges with fine horsehair and remove the sutures in 5 days to avoid scar formation. If it is impossible to obtain intranasal splints, packing of mercurochrome may be inserted into each nostril and tongue depressors are properly fitted to either side of the nose and fastened with collodion or adhesive.

Fracture of nasal bone. Bones [illegible]

The patient should be kept under the surgeon's care for two or three weeks. Occasionally resection of the septum is necessary if the nostrils have not been correctly molded and protected.

Fractures of the Malar Bone and Zygoma

A simple open fracture without depression of bone calls only for the usual surgical treatment of open fracture—cleansing, reduction, removal of any small fragments and closure of the wound. A fracture with depression deformity, whether impacted or not, which interferes with functioning of the jaw calls for open surgical operation especially if there is nerve pressure with sensory disturbance.

Step 1. The incision should be small, not more than half an inch in length, to avoid facial scar. This will permit the introduction of a chisel or hook to elevate the bone into its correct place. When replaced in anatomic position, the bone tends to remain so.

Step 2. Close the wound and avoid pressure on the area for some weeks.

FRACTURE OF THE SUPERIOR MAXILLARY BONE

In closed fracture the patient has the alternatives of possible deformity or of open operative reduction and correction. Although the fractured bone may be reduced by manipulative methods, it is hard to keep the reduction maintained. Opening up by surgical incision affords an opportunity for correct replacement of the fractured fragments.

Open fractures of the superior maxilla are treated surgically in the same general way as an open fracture anywhere else, namely aseptic debridement, reduction and closure. If the fragments cannot be maintained in replacement the teeth may be wired and the fragments held by interdental splints. The services of a dentist are called for in such a procedure.

FRACTURES AND DISLOCATIONS OF THE LOWER JAW

(See Chapter on Surgery of the Head, pp. [illegible], Figs. [illegible])

Like fractures of the superior maxilla, reduction and maintenance of fragments is difficult in fractures and dislocations of the mandible. The age of the patient, the occupation, the time elapsed since the injury and the probable cosmetic result have all to be considered in operating for a fracture or dislocation of the mandible.

Step 1. The skin incision is made below the zygoma and the dissection carried down to the mandible by splitting the muscles and retracting them. Care must be taken to avoid any important blood vessels or branch of the facial nerve. If the fracture is condylar, Murphy's approach by a [illegible] incision starting on the level of the zygoma and half an inch in front of and on a line with the external auditory meatus can be used. If necessary, this affords an opportunity for the use of a flap of temporal fascia should an arthroplasty be called for to avoid jaw ankylosis.

Step 2. The fractured mandible is reduced. If the condyle cannot be managed satisfactorily it should be removed and an arthroplasty done as described. The use of a prosthetic apparatus may be necessary to maintain the reduced fragments in position.

FRACTURES OF THE PELVIS

As a general rule, closed fractures of the pelvic bones—ilium, ischium, pubis, acetabulum, sacrum and coccyx—do not call for open surgical operation (Figs. [illegible]). These injuries are treated by manipulative methods, which include placing the patient on a fracture table and applying continuous or skeletal traction through the ischium and by immobilization in a cast after the fragments have been reduced. Operation may be necessary when some internal viscus is injured concomitantly with the fracture.

SACRO-ILIAC JOINT

Sprains and dislocations of the sacro-iliac joint (Fig. [illegible]) are followed by incessant and excruciating pain and complete disability. In some, as well as for irreducible separation of the surfaces of this joint caused by a pelvic fracture, open surgical treatment is indicated. T[illegible]

Fig. 1112. Fracture of the pelvis.

Fig. 1113. Multiple fractures of both pelvic bones, with displacement of fragments.

consists in curetting the joint surfaces followed by bony fixation by means of bone graft.

Step 1. An incision is made downward and outward from the third lumbar spine to the crest of the ilium or below it. The skin, fat and fascia are dissected up and retracted away from the joint which is exposed.

Fig. 1114. Diagnostic maneuver. Helpful in differentiating between sacroiliac and lumbosacral lesions. The sketch shows forcible hyperextension of left hip, with pelvis and lumbar spine fixed by means of extreme flexion of the right leg. Pain ... [illegible] (Courtesy of Dr. J. Gaenslen.)

Step 2. The joint is opened and curetted. An osteoperiosteal bone transplant about 3 inches in length is taken from the tibia and driven diagonally across the sacro-iliac joint from above downward into the sacrum in which a gutter must first be prepared for it.

Step 3. Close the wound in layers. No plaster cast is necessary but the patient should be kept in bed for about 6 weeks after which he is allowed to walk.

Smith-Petersen Operation

Step 1. Begin a curvilinear incision at the iliac crest midway between the anterior and the posterior superior iliac spines. Carry the incision posteriorly around the posterior iliac spine and thence down and outward for about

four inches. Reflect the flap and underlying muscles laterally exposing the surface of the ilium (Figs. 1115 A B).

Step 2. Define the sacroiliac joint. Remove a generous rectangular bone wedge which includes the whole thickness of the ilium and passes through the sacroiliac joint. With the joint thus exposed cartilage and underlying cortex are removed down to cancellous bone.

Step 3. Remove all cartilage from the bone wedge and then replace the block in its original site. Cancellous bone surfaces are thus brought into apposition.

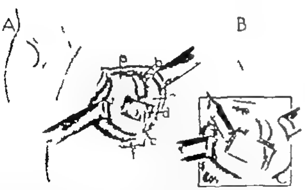


Fig. 1115. Operative treatment of sacro-iliac ... A. Line of incision. B. ... surface of ilium ... [illegible] C. Bone wedge after being replaced ... [illegible]

Step 4. The surface of the bone wedge now lies below the surface of the ilium. To promote stability the edges of the latter are broken in over the wedge with a bone chisel (Fig. 1115 C).

Step 5. Carefully replace and firmly suture the reflected structures. Dress and confine the patient in continuous recumbency for about three months.

Gaenslen's Technique of Sacro-Iliac Arthrodesis

Place the patient in a semiprone position. In the case of stout or short-waisted patients flex the table at the center with the pelvis at the flexion thus bringing out the crest prominently. Mark the location of the posterior superior and posterior inferior spines before preparing the skin for identification and proper placement of the skin incision.

Step 1. Make an incision along the posterior two-thirds of the iliac crest, curving around behind the posterior superior spine and ending over the posterior inferior spine of the ilium. Penetrate the skin and subcutaneous fat to the

deep fascia. Liberate the wound margins and retract them thus exposing the crest to the posterior superior spine (Fig. 1116).

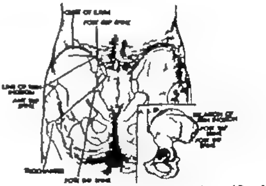


Fig. 1116. Line of skin incision with reference to skeletal landmarks. (Courtesy of Dr. J. Gaenslen.)

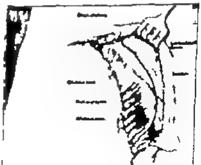


Fig. 1117. Curved skin incision along crest ... [illegible] posterior third of crest. (Courtesy of Dr. J. Gaenslen.)

Step 2. Make an incision over the posterior third of the crest and over the posterior superior spine, leaving a small margin of fascia and muscle on the outer lip of the crest to facilitate the closing (Fig. 1117).

Step 3. Split the posterior portion of the ilium ... with a broad chisel to a depth of ½ inches forward from the posterior superior spine ... [illegible]

and outer leaf the latter being the thickest. Keep the plane of the joint and its relation to the normal bony landmarks well in mind. The chisel

Fig. [illegible] Diagram of posterior third of [illegible] split by chisel. [illegible] (Courtesy of Dr. F. J. Gaenslen.)

Fig. [illegible] The inner leaf of the [illegible] ilium. [illegible] (Courtesy of Dr. F. J. Gaenslen.)

set against the posterior superior spine should be held in a plane parallel with that of the posterior third of the ilium, and should be directed forward and slightly outward in the direction of the anterior superior spine of the

same side (Fig. [illegible]). In splitting the ilium, center the chisel over the posterior superior spine in the direction above recommended unless he split upward and downward enough to separate the entire posterior third close down to the posterior inferior spine.

Step 4. Split the ilium to a depth of about [illegible] inches (it cannot be split to the required depth in an unbroken leaf on account of its curve). Reflect laterally the outer leaf of bone with the attached gluteal muscles and overlying tissues (Fig. [illegible]). Further split the remaining portion of the posterior third with the chisel and reflect it out thus obtaining satisfactory exposure of the sacro-iliac joint. Danger of going too deeply is avoided if the anterior superior spine is used as a landmark.

Step 5. Next attack the part of the inner leaf overlying the joint. Dissect a triangular area of bone corresponding in size and location to the sacro-iliac joint on the inner or standing leaf of the ilium. The portion of bone to be removed is identified as follows (Fig. [illegible]). The base line BC, [illegible] inches long, extends forward from the posterior inferior spine directly toward the anterior superior spine. The line BA, one and one-half inches long, is erected almost perpendicularly from the anterior end of the first incision toward a point on the crest joining the middle and posterior third; the resulting angle is a little less than a right angle. Join the points CA. It is not necessary to remove this triangular area of bone in one piece; it is better to remove it in pieces and save the healthy parts for filling in the defect later.

Fig. [illegible] Lateral aspect of left iliac bone. The area of [illegible] is shown by dotting; the triangle outlines the area through which the joint is approached. (Courtesy of Dr. F. J. Gaenslen.)

Step 6. The entire joint is readily exposed after the cartilaginous surface is identified in the center of the triangle, especially in a tuberculous joint where the opaque white cartilage partially bleached by granulation tissue is readily followed. The diseased part of the cartilage is removed in fragments as the joint is uncovered with chisel and curet (Fig. [illegible]).

Step 7. Pack the cavity thus made with pieces of healthy bone chips removed during the procedure (Fig. [illegible]—Insert). Bring the reflected outer leaf of the ilium into apposition and hold it in place with a few interrupted sutures into the dorsolumbar fascia and muscle. Complete closure with subcutaneous catgut and silk skin suture.

Comment. Gaenslen recommends that a plaster spica be worn for ten or twelve weeks followed by a pelvic belt in the case of tuberculous patients. This procedure does not weaken the posterior sacro-iliac ligaments in any

way; exposure is ample; danger from hemorrhage is negligible and closure is simple and secure.

Putti's Technic for the Removal (Apophysectomy) of the Transverse Process of the Fifth Lumbar Vertebra (Sacralization)

V. Putti and O. Scaglietti[1] give as an indication for this operation persistent low backache caused by an osteoarthrosis in a false joint formed by the approximation of the transverse process of the fifth lumbar vertebra with the wing of the ilium.

Step 1 (Fig. [illegible] A). Make a midline cutaneous incision extending from the second lumbar vertebra to the spine of the fifth lumbar and having a hockey stick curve over the corresponding sacro-iliac joint.

Step 2 (Fig. [illegible] B). Expose the lumbo-sacral aponeurosis.

Step 3 (Fig. [illegible] C). Retract the lumbosacral muscles and remove the posterior portion of the crest of the ilium thereby exposing the sacralized transverse process of the fifth lumbar vertebra.

Fig. [illegible] Exposure [illegible] sacro-iliac joint and removal of articular surface with gouge. The insert shows the joint packed firmly with healthy bone chips. (Courtesy of Dr. F. J. Gaenslen.)

Step 4. Make an incision for the removal of the sacralized transverse process of the fifth lumbar vertebra as shown in Fig. [illegible] D.

Comment. Fig. [illegible] E shows conditions after removal of the sacralized process of the fifth lumbar vertebra with the exposure of the iliopsoas muscle and branches of the lumbo-sacral plexus. The postoperative care in these cases is bed rest without any cast for a period of four to six weeks.

DISLOCATIONS AND FRACTURES OF BONES OF THE LOWER LIMB

DISLOCATIONS OF THE HIP

Simple dislocation of the hip is usually readily replaced by such a maneuver

[1] Chir. d. [illegible] Vol. XVII, [illegible]

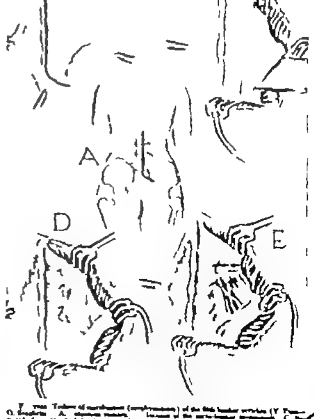


Fig. [illegible] Technic of [illegible] (apophysectomy) of the fifth lumbar vertebra (V. Putti—O. Scaglietti). A. [illegible] incision. B. [illegible] of the sacro-lumbar aponeurosis. C. [illegible] of [illegible] of the iliac crest after the aponeurosis and muscles have been dissected [illegible] D. The sacralized transverse process [illegible] portion of the ilium has been [illegible] E. Removal of [illegible] of lumbar vertebra [illegible] the iliopsoas muscle and branches of the nerves [illegible]

as shown in Figs. [illegible]. For severe crushing injuries and old-standing hip dislocations due to any cause with functional disability, open surgical treatment is generally demanded. Following an accident, if the patient is in a state of shock, operation should be deferred until shock has subsided; the blood vessels are rarely injured. A dislocation may be posterior, medial or anterior and the approach will be different in each case.

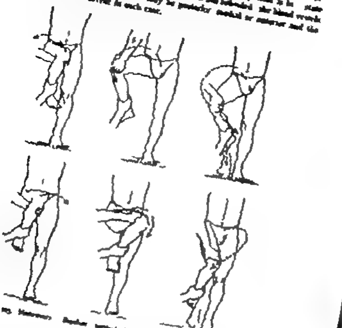


Fig. [illegible]. [illegible] method of reducing hip dislocated posteriorly.

Reducing a Dislocated Hip by the Shoulder Method

The patient is placed on the operating table, the pelvis projecting a little over the edge of the table. The sound limb is supported by one surgeon while the other stands in the space of the [illegible]. The limb [illegible] outward with reducing the dislocation [illegible] between the patient's legs.

Step 1. The knee of the patient is placed over the shoulder of the surgeon. The left hand supports the lower part and the right hand the upper part of the leg.

Step 2. The person supporting the limb rises slowly, keeping the limb [illegible] but abducted. When the upright position is attained, the affected limb [illegible]

all be vertical and flexed at a right angle to the pelvis. A sharp movement of the shoulder increases the upward traction and disengages the head of the femur from its abnormal position.

Fig. [illegible]. The shoulder method of reducing a dislocation of the hip. Step [illegible]. Placing the patient [illegible] of the affected limb over the shoulder and the [illegible] position of the surgeon and assistants.

Posterior Dislocations

Step [illegible]. The surgical incision usually runs from the postero-inferior iliac spine to the base of the large trochanter. In old standing cases the head of the femur is usually found under the gluteus maximus muscle; the obturator internus, the gemelli and the pyriformis muscles are generally found stretched over the acetabulum.

Step 2. The femoral head must be detached from all pelvic connections, the muscles stretched over the acetabulum pulled away, the acetabulum cleaned out and the femoral head levered into place by circumduction.

Step 3. Close the wound. Immobilize in plaster of Paris cast.

Anterior Dislocation

Step 1. The access to the acetabulum is covered by the [illegible] and by the muscles already mentioned. Such must be retracted, dissected or incised and the acetabulum cleaned out.

Step 2. First and outwardly rotate the thigh; such removes the trochanter from its blocking position.

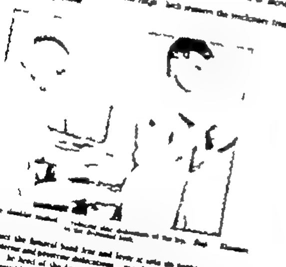


Fig. [illegible]. The shoulder method [illegible] reducing after dislocation of the hip. Step [illegible]. [illegible] to the dislocated limb.

Step 3. Dissect the femoral head free and bring it into its anatomic position. Both in anterior and posterior dislocations it may be better in some instances to resect the head of the femur. An arthroplasty is then done. [illegible] lower femur [illegible] the [illegible] head of the femur and the acetabulum [illegible] however [illegible] in the abducted position of abduction may often be the preferential mode of dealing with a given case.

Open Hip Fractures or Dislocations

Here the general surgical indications are in order.

Step [illegible]. Aseptic preparation of the site of injury. Then careful debridement of the wound and search for the injured area.

Step [illegible]. If the head of the femur is found broken or if the acetabulum is damaged [illegible] must be effected or attempted, resection of the head of the femur may be necessary. The upper end of the femur is [illegible] and inserted into the acetabulum.

Step 3. If there is no fracture after thoroughly cleansing the area, reduce the head of the femur in its anatomic position and close the wound with

capillary drain under the skin. The great deliberation in such cases is the avoidance of infection and subsequent ankylosis.

CONGENITAL DISLOCATION OF THE HIP

Congenital dislocation of the hip, consisting of a partial or complete displacement of the head of the femur from the acetabulum, is one of the most common and important of congenital orthopedic disabilities. It has been recognized since the time of Hippocrates and efforts at closed reduction methods were made by [illegible] as early as [illegible]. [illegible] demonstrated that manual reduction was possible but it remained to Lorenz to effectively [illegible] and thus create the correction. Surgical reduction by placing the femur head was carried out by [illegible] in [illegible].

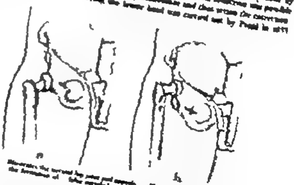


Fig. [illegible]. Illustrates the normal hip joint and capsule. [illegible] congenital dislocation with the formation of [illegible] acetabulum and an "hour glass" capsule.

and well executed open operation was performed by Hoffa in [illegible]. At the present time there is a [illegible] tendency in children, to resort more frequently to manipulative methods [illegible] surgery for established cases. Such cases or such cannot be reduced [illegible] surgical intervention is always necessary. [illegible] has aptly stated that "Congenital dislocation of the hip joint is a deformity [illegible] in [illegible] to the final crippling results." [illegible] at birth the real cause has not been satisfactorily explained. There are those who believe that [illegible] is more or less responsible and others that the deformity arises from an imbalance in the growth of cartilage and osseous tissue in the formation of the acetabulum. Of the sufferers, [illegible] per cent are females. In both sexes about [illegible] per cent of the cases have [illegible] history extending over [illegible] or more generations. [illegible] the patient is of [illegible] phenotype and [illegible] deformities are not common. The dislocation [illegible] is frequently double.

The pathologic changes seen in the acetabulum consist of an underdeveloped cup resulting in a shallow cavity into which [illegible] growth takes place. The head of the femur leaves the acetabulum being displaced backward and upward. Secondary changes result and [illegible] becomes small, [illegible]

shapen and generally flattened. The joint capsule is carried upward by the femur head and the result [illegible] is responsible by hypertrophy of the capsule [illegible] the pelvis (Fig. [illegible]). The femur neck is [illegible] and appears [illegible] from the shaft (Fig. [illegible]). These [illegible] changes [illegible] pelvis [illegible] and the normal lumbosacral lordosis [illegible] increase. [illegible] lateral deformity [illegible] of the affected [illegible] portion of the pelvis [illegible].

Children [illegible] of the hip tend to [illegible]. [illegible] of [illegible] trochanter [illegible] the greater trochanter in the gluteal [illegible]. [illegible] but [illegible] external rotation of the affected limb may be

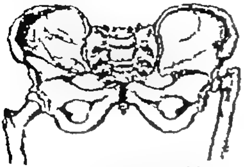


Fig. [illegible]. Unilateral congenital dislocation of the hip.

noted. When walking is attempted the unilateral [illegible] limb toward the affected side [illegible] develop [illegible] so-called "duck waddle" or "sailor [illegible]". There [illegible] an increase in the normal lumbosacral lordosis and upon measurement the involved limb [illegible] found to be shortened. Trendelenburg [illegible] sign (Fig. [illegible]) is present and upon stereoscopic x-ray [illegible] the dislocation of the head of the femur onto the dorsum ilii will be seen [illegible] (Fig. [illegible]).

The object of treatment is to reduce the congenital dislocation by placing the head of the femur into the acetabulum and there maintaining [illegible]. This [illegible] followed by therapy designed to restore function to the joint. Several [illegible] obstacles exist which tend to prevent [illegible] success, namely the very shallow acetabulum, the anteversion of the femur neck, and the shortened muscles of the hip joint and thigh. Reduction may be effected by manipulative methods or surgical means. Successful manipulation is generally not difficult in the child that has not reached the age of six. [illegible] if the age of the patient approaches ten years the surgeon must choose his cases very carefully. After the age of ten and in those cases which are irreducible or which redislocate after successful manipulative procedures, open operation must be resorted to.

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Trendelenburg sign. [illegible] change in the [illegible] produced by the [illegible] of the [illegible] standing on the [illegible] leg.

Fig. [illegible]. Trendelenburg sign. [illegible] the [illegible] of the dislocated hip [illegible] with the leg.

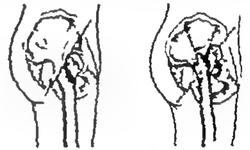


Fig. [illegible]. [illegible] congenital dislocation of hip [illegible]. The figure on the right shows the [illegible] of the dislocated hip.

Before [illegible] to manipulative procedures, have the child in traction for [illegible] three weeks.

Manipulative Reduction

Step [illegible]. Place the child on her back upon [illegible] table. Bring the hip to be manipulated to the table edge and have an assistant fix the opposite thigh and pelvis.

Step [illegible]. The operator then gently puts the affected limb through its full range of motion by [illegible] flexion, extending, abduction and rotating.

Step [illegible]. The knee is then flexed to [illegible] degrees where [illegible] on the thigh [illegible] flexed to about [illegible] degrees.

Step [illegible]. The thigh [illegible] rotated [illegible] slowly abducted [illegible] the same time [illegible] pressure [illegible] applied [illegible] trochanter in order to push the femur head forward [illegible] and the head is [illegible] to slip into place over the [illegible] rim.

Fig. [illegible]. Apparatus for the treatment of congenital dislocation [illegible] hip [illegible]. The [illegible] abduction [illegible] by [illegible] on the posterior [illegible] of the [illegible].

Step [illegible]. Repeat steps [illegible] and [illegible] several times if necessary.

Step [illegible]. With the deformity reduced abduct the thigh at right angles with the body so that the medial surface of the knee [illegible] plane including the anterior superior iliac spine. The femur head [illegible] carefully seated in the acetabulum by an assistant.

Step [illegible]. Apply [illegible] plaster of Paris spica from the nipple line downward to include both legs to the ankle [illegible] of unilateral cases.

The careful application of the spica [illegible] exceedingly important. Following [illegible] an x-ray [illegible] made [illegible] the position attained [illegible] satisfactory allow the cast to remain in place for one week before attempting [illegible] reduction. A satisfactory reduction [illegible] kept in place for three months and then replaced [illegible] new casts. [illegible] the limbs, after three or four [illegible], into their normal position. Physiotherapy [illegible] to help rehabilitate the hip joint (Fig. [illegible]).

Certain cases are not [illegible] to redislocation after primary reduction. [illegible]

[illegible] the shallowness of the acetabulum [illegible] deformity of the femur head makes reduction impossible or unsatisfactory. Soft tissue changes may be so advanced and bony changes in the [illegible] of the dislocation of the femur

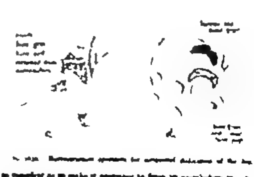


Fig. [illegible]. [illegible] operation for congenital dislocation of the hip.

head so complete as to make it necessary to form an acetabulum at [illegible] new location. The operative treatment of these cases is as follows:

Operative Treatment of Congenital Dislocation of the Hip

Step [illegible]. Carry a curved incision forward in the line of and just below the iliac crest from well back on the dorsum to the anterior superior iliac spine and thence down the thigh for four inches (Fig. [illegible]). [illegible] the [illegible] muscle at its insertion on the anterior superior iliac spine. With curved [illegible] detach the [illegible] muscle [illegible] from the [illegible] insertion on the iliac crest. [illegible] the [illegible] down to the bone and strip them away from the ilium by [illegible] (Fig. [illegible]) (Smith-Petersen). The capsule [illegible]

is complete [illegible] the anterior inferior iliac spine is brought into view and the attached rectus femoris muscle detached.

Step 2. Retract the soft tissues thus exposing the joint capsule which is opened parallel to its fibers. The state of the acetabular cavity is determined and its upper limits accurately outlined. The fibrotic tissue making up the false socket is stripped downward from the ilium until the upper edge of the acetabulum is reached where the tissue is then trimmed so as to contribute to the upper surface and brim of the natural joint.

Step 3. Using [illegible] gouge the superior half of the acetabular cavity is carefully deepened and cupped to as great [illegible] depth as the thickness of the ilium [illegible] permit.

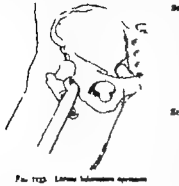


Fig. [illegible]. Lorenz bifurcation operation.

Step 4. With [illegible] bone chisel [illegible] concentric incision is carried around the acetabular margin one centimeter from its border. The bony tissue which is thus loosened represents [illegible] "half cup" form and is pried down over the head of the femur until the *normal cavity of the joint is restored* (Fig. [illegible] 32-c).

Step 5. Remove [illegible] crescentic piece of bone from the ilium designed to fit the defect created between the ilium and the restored superior acetabular margin. When properly arranged nail or screw the graft securely in place (Fig. 32-d).

Step 6. Test the joint thus restored. Carefully close the capsule (a reconstruction may be necessary) and then close the wound in layers making use of [illegible] strong absorbable sutures.

Step 7. Place the leg in [illegible] plaster spica like that used following manipulative procedures. Remove the cast in two to four months and institute physiotherapy for the joint.

Comment. In those cases in which [illegible] manipulative reduction cannot be effected although roentgenograms reveal no gross deformity an open operation is indicated. The exposure is that of Step [illegible] in the preceding technic. The capsule is opened and any constricting areas incised, the femoral head is then levered into the acetabulum. The capsule is then closed and the tensor fascia latae and the gluteal muscles are sutured to the lateral abdominal muscles which overlap the iliac crest. No reconstructive procedures are carried out upon the head of the femur or the acetabulum.

Adults with unreduced dislocations of long standing may complain of pain resulting from [illegible] traumatic arthritis in the false hip joint and abnormal muscle pull in back. When other methods fail the bifurcation operation of Lorenz is an excellent palliative procedure. An incision is

made vertically down the lateral thigh region over the anterior inferior iliac spine. The femur is exposed and an acutely oblique osteotomy performed. The limb is then abducted, the upper end of the lower bone fragment is introduced into the acetabulum and there maintained by means of [illegible] plaster spica (Fig. 133). Union occurs and the resulting "bifurcated" femur end rests upon bone instead of soft tissue.

FRACTURES OF THE FEMUR

According to the Report of the Committee on Fractures of the American Surgical Association, published in 1931, surgeons in the United States by average, nonoperative treatment obtained good functional results in [illegible] per cent of femur fracture cases. Twenty-three per cent of fractures of the femur of all regions were treated by open surgical operation, the majority being shaft fractures, especially of the middle third. The Report states that "although anatomical results are rated good in [illegible] per cent of the open, operated cases as against [illegible] per cent in the non-operated, good functional result is only [illegible] per cent as compared with [illegible] per cent in the non-operated cases." The operated cases were mostly in adults.

Fig. [illegible]. [illegible]

The open surgical treatment of fractures of the femur when indicated will vary according to the position and type of fracture. Operation is indicated in case of [illegible] simple fracture when there is evidence of internal bleeding, the object being to seek the injured vessel and ligate it (Figs. [illegible]).

Compound Fractures

No matter what may be the site of fracture, the general surgical indications are always the same for open treatment, namely, to enlarge the wound, to open up and irrigate the whole area of injury with physiologic salt solution, to wash away clots, to remove debris and loose splinters, to reduce fragments with exact coaptation, and to immobilize the limb.

The general procedure will vary somewhat according to the site of fracture and its nature.

COMPOUND COMMINUTED FRACTURE OF THE FEMUR

Operation for fractures with large fragments but without serious vascular lesions.

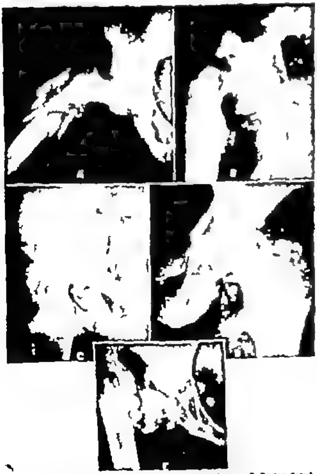


Fig. [illegible]. [illegible] Compound comminuted fracture upper end of femur. B. Fracture through [illegible] femoral head with upward displacement of shaft. [illegible] D. Comminuted [illegible] E. Old [illegible] fracture of femur with upward displacement of shaft.

Open Treatment

Step [illegible]. Prepare the region, irrigate and remove tags and débris. If there are any completely detached bone splinters remove them also.

Step 2. Open up the wound by an extensive longitudinal incision and, if necessary, enlarge it transversely. Cleanse thoroughly and examine all tissues minutely. If any protruding piece of bone is found widely stripped of periosteum, [illegible] or chisel away its extremity [illegible] it into a wedge.

Fig. [illegible]. Fracture of the neck of the femur.

Treat the other fracture fragment the opposite way so that the two fragmental ends can be brought into close contact.

Step 3. Coapt the two fragment ends as well as possible. Leave everything open placing drainage tubes in suitable positions and pack the wound lightly with gauze only when primary closing of the wound seems inadvisable. Immobilize the limb in plaster of Paris cast.

Closed Treatment for Fracture of the Neck of the Femur

Step [illegible]. The patient [illegible] placed in position on the fracture table, traction being applied, the leg being in [illegible] and abduction (Fig. [illegible]).

Step [illegible]. Following reduction, [illegible] plaster cast is applied, all bony points being well protected by padding to avoid pressure necrosis. Buck's extension and Thomas splint may be used but usually gives poor results.

Step 3. Immediately after reduction and at the end of six weeks roentgenograms are made to determine the position of the reduction and to ascertain the condition of the head of the femur. The cast is generally removed after 16 to 18 weeks, and massage, passive and active movements begun.

Open Treatment for Fracture of the Neck of the Femur

Several incisions have been devised to approach the hip joint. One of these incisions will form the first stage of the operation.

Step 1. (a) The anterior angular incision, between the tensor vaginae femoris and the sartorius muscle, which avoids cutting of muscles. Division of the fascia and deep separation immediately exposes the femoral neck.

(b) The Kocher or posterior incision which necessitates cutting the gluteal and the periformis muscles.

(c) The lateral U-shaped or straight incision about the trochanter and reflection of a flap of skin, fat and fascia. The great trochanter and its attached muscles is cut through with a Gigli saw and reflected upward which exposes the femoral neck and the joint capsule.

Whatever incision is employed, and when the joint is exposed if it is not open, it is incised and, by abducting and rotating the limb outward, the fragments are brought into view.

Step 2. The fracture is examined especially as to viability of the femoral head and the feasibility of approximating the fragments. If the head is viable the fractured ends are freshened and may be united by an autogenous bone peg driven through the trochanter into the head of the femur, the leg being held in abduction and inversion with mechanical traction.

Step 3. The joint capsule is closed by catgut sutures and the trochanter again attached to the femur by a nail or sutures and the soft parts united.

Fracture-Dislocations of the Neck of the Femur

In old fracture-dislocation cases, when the acetabulum has become filled with fibrous tissue, it is gently scraped out without injuring the cartilaginous surface before the unattached femoral head is replaced in the cavity; the turned-in part of the capsule must be cut away from the margin of the acetabulum to prevent ankylosis, or some other plastic procedure adopted.

This type of operation is called for (a) in cases of old unrecognized fracture with disability and shortening; (b) following nonunion after any kind of treatment; (c) for unsatisfactory functional results following any type of treatment.

Step 1. An angular incision is made running from the anterosuperior spine of the ilium to the trochanter and then turning down along the shaft of the femur.

Step 2. The trochanter of the femur is exposed, cut and reflected upward and the hip joint capsule and fracture field opened up. It may be necessary to trim away a considerable part of the trochanter and the head of the femur.

Step 3. Ununited fracture may be treated by simply freshening the bone ends with subsequent treatment as if it were a recent fracture, or by nailing, bone-pegging, etc., an autogenous bone peg being preferentially used. Bony

union may and usually is obtained with some shortening and lameness, but otherwise there is a useful limb.

Step 4. If the head of the femur is found in such a condition that its removal is necessary, an effort must be made to obtain bony union of the proximal end of femur to the pelvis which, of course, gives shortening and lameness.

In children the best surgical operative treatment of old fracture of the surgical neck of the femur is a cuneiform osteotomy or subtrochanteric osteotomy to permit the leg to be swung into abduction to make up for the lessened angle of the neck of the femur.

Fig. 137. Patient, [illegible] years of age. Intertrochanteric fracture of the right femur of [illegible] Patient [illegible] (Surgical Service, Cook County Hospital.)

Fractures of the Greater and Lesser Trochanters of Femur

These fractures are usually treated by manipulative reduction and immobilization (Figs. 137-138).

Fracture of the Shaft of the Femur

Continuous suspension traction has become generally adopted in the treatment of closed fractures of the shaft of the femur as otherwise it is very difficult to maintain accurate reduction of the fragments (Figs. 139-140). Skeletal traction obtained by means of a Steinmann nail or wire passed through the calcaneum, is employed with excellent results. The point for insertion of the nail or wire is usually the outer side of the heel about the middle of the bone; the nail is driven parallel to the sole of the foot right through the inner side of the foot so that part of it projects at each side which may be used as means of fixing the traction. Of course, the strictest aseptic precautions must be observed.

Steinmann nail or wire traction is also employed in open surgical treatment of shaft fractures (Fig. 141). Operative treatment is usually reserved for cases of delayed or nonunion, or very faulty union resulting from manipulative methods.

Step 1. Preparation for continuous or skeletal traction as above. The patient is placed on a fracture table.

Step 2. The surgical approach is by an incision on the lateral aspect of the thigh at the site of the fracture, opening up of the site of the fracture, exposure of fragments and their reposition after freshening bone ends and removal of callus, if any. The fragments are locked together by the use of internal splints, nails, screws, metal plates or bone splints as may be decided upon.

Step 3. Closure of the wound with capillary drainage. Application of plaster

cast or external splints. Usually no matter how carefully the fragments are aligned, some degree of shortening results. Immobilization is necessary for 7 to 8 weeks and walking calipers must be employed for 3 to 6 months while the patient is ambulatory (Fig. 140).

Open Fractures of the Shaft of the Femur

The surgical treatment is the same except for the preliminary cleansing and débridement of the wound and controlling hemorrhage, if any.

Supracondyloid and Intercondyloid Fractures of the Femur

The treatment of such fractures is usually manipulative but open surgical operation is indicated if there are complications such as laceration of the popliteal vessels or when the fragments are very widely separated.

Step 1. Incision is made on the outer aspect of the thigh and the dissection is carried down to the bone.

Fig. 138. Intertrochanteric fracture of the right femur treated with Buck's extension and 20 pounds of weight. Foot at right angles and leg in abduction. Patient 60 years of age. (Surgical Service, Cook County Hospital.)

Step 2. Exposure of fracture fragments. Identification and examination of blood vessels and repair if necessary.

Step 3. Alignment of fractured bone ends and their maintenance by plate, screw or nail. Plates are of little use.

Step 4. Application of plaster cast or splints for 8 to 9 weeks. Opening of the knee joint must be avoided.

Epiphyseal Separation of the Distal End of the Femur

Open surgical treatment is usually indicated as manipulation generally fails.

Step 1. Open up the site of injury.

Step 2. An attempt should be made to adjust the fracture fragments by leverage and traction without resection of the diaphysis or any part of the epiphysis.

If successful, continue with nail or screw driven through the diaphysis to hold the lower fragment, but if the lower fragment is split it may be nailed to the diaphysis by a nail or screw from either the joint or shaft side.

Step 3. When the bone ends are united, examine the fracture site for injuries to vessels, nerves, etc. Do not open the knee joint unless imperative. Close.

UNUNITED FRACTURE—PSEUDARTHROSIS

Separation of the fragments, unsatisfactory immobilization and the interposition of tissues between the fragments are responsible for nonunion of fractures (Fig. 143). This condition is remedied by operative procedures designed to:

(a) Remove interposed tissue,

(b) Freshen the fractured bone ends and

(c) Fix the fragments in position.

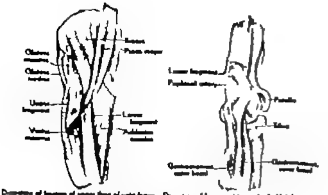
Fig. 143. Nonunion of fracture of the shaft of the femur.

Operation

Step 1. Obtain exposure via the route requiring the least destruction of tissues. In case of fracture of the humerus, avoid injuring the musculospiral nerve and other important structures. Incise between muscles rather than through them. A longitudinal incision is usually preferred. An elastic constrictor should be used only when absolutely necessary.

Step 2. Make a vertical incision through the skin down to the fascia. Reflect the skin from the fascia for a short distance on either side of the incision to locate an intermuscular septum. Incise the fascia here and penetrate the intermuscular septum to the bone by means of sharp and blunt dissection. Expose the bone by means of retractors. Let the incision be ample. The surgeon must have plenty of room to see what he is doing and to accomplish his task without being hampered by obstructing structures.

Step 3. The bone ends are prepared in accordance with conditions found at the site of fracture. All fibrous tissue, muscle, etc., are cut away from the bone ends. Deliver each fragment from the wound and with rongeur nip off thin slices of bone end until healthy bleeding bone is obtained. If the bone ends cannot be satisfactorily delivered, they may be effectively sawed off in situ with a Gigli saw or chisel. It is



Deformity of fracture of upper third of right femur, showing flexion and outward displacement. Deformity of fracture of lower third of left femur, showing displacement of popliteal artery by lower fragment.

Fig. 1138. Fracture of upper third of femur. (Human Anatomy.)

Fig. [illegible]. Use of Steinmann nail through the os calcis. Note block for elevating the purpose of either traction or extension in aligning the foot.

to saw the bones in such a manner that they may be mortised together and then obtain fixation.

A. O. Wilding[1] describes a method of operating on ununited fractures as follows:

Step 1. Expose the fracture site and pull the bone ends out into the wound. Verify the end surfaces by sawing off thin slices as described in Step 3 of the foregoing procedure.

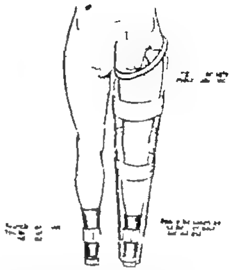


Fig. 1139. Weight-relieving caliper.

Step 2. With a gouge or drill remove the plugs of callus or fibrous tissue. By means of drills Nos. [illegible] and 3 penetrate the hardened bone in four or five places parallel to the long axis of the bone. The drills penetrate until they reach normal bone which is made known by bleeding and lessened resistance to the instrument—usually a depth of one or two inches.

Step 3. After thus treating both fragments fixation is accomplished by means of Lane's plates.

Wilding comments that satisfactory and firm union takes place despite the presence of callus redundancy.

[1] Brit. J. Surg., [illegible] p. [illegible]

Methods of Uniting Bones

In some few cases the fragments of bone show signs of remaining in place permitting the wound to be closed and splints applied. However, it generally becomes necessary to inaugurate other measures to bring about direct union.

Transverse or oblique fractures may be united with silver wire or chromicized catgut as depicted in Fig. 1144 (B, C, D).

Another method used where the fractured surfaces are oblique is to drill hole transversely through both bone fragments. Leave the drill in place. Bore another hole through both fragments with another drill. Remove the first drill and put a bone peg in its place. After the pegs are in position, any protruding part may be cut off even with the bone surface. Metal nails or screws may be substituted for the bone pegs.

Fig. 1143. Fracture of both bones of the leg. Improper reduction. Malunion. Reconstructed from x-ray.

In some instances the drills used to pierce the bone are left in situ with their outer ends emerging through the soft parts of the wound. The drills become loose after two or three weeks and are then easily removed.

Fixation is also brought about by the use of intramedullary pegs, internal splinting, long screws and external clamps. Figures 1144 and [illegible], p. [illegible] depict various methods of fixation.

DISLOCATIONS AND FRACTURES OF THE KNEE

Dislocation of the knee is usually due to injuries to the cartilages about the joint. Such dislocations, if recurrent or habitual, may call for open surgical correction.

Dislocation of Cartilages

Step 1. An angular incision about 4 to 5 inches long is made over the lateral aspect of the joint on the side affected, with the knee hanging over the edge of the table.

Step 2. The muscles are retracted and the cartilages—usually the semilunar—are exposed, grasped by forceps and dissected out. No attempt should be made to suture the cartilage in place as such procedure has generally been abandoned. The knee joint is not manipulated in any way.

Step 3. The wound is closed in layers.

Note: If there are any loose pieces of cartilage in the posterior recesses or bursae in the popliteal space it may be necessary for their removal.

DISLOCATION OF THE PATELLA

This is usually due to rupture of the joint capsule without bone fracture. The dislocation is likely to become habitual and hence open surgical operation is indicated to close the joint firmly.

1. Make an arthrotomy incision [illegible] to 6 inches long on the inner aspect of the front of the knee joint. The joint capsule and quadriceps muscle, which is also usually injured, are exposed.

Step 2. The injured structures—capsule, muscle and ligaments—are repaired layer by layer. The semilunar cartilages should be carefully examined. In recurring dislocations, especially if there is knock knee, a preliminary osteotomy may be necessary.

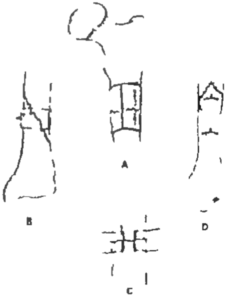


Fig. 1144. A. Metal collar for fixation of fractures. B, C, D. Wire sutures for oblique and transverse fractures.

Step 3. Close the wound without drainage and use walking calipers for an extended period.

A great many methods of surgical treatment of recurrent dislocations of the patella have been devised.

Recurrent Dislocation of the Patella

The patella may be dislocated either as a result of trauma or congenital abnormality or both. The direction of most frequent displacement is lateralward. The congenital type is usually associated with an underdeveloped lateral condyle combined with a weakness of the ligaments of the quadriceps extensor

muscle. The traumatic type occurs most frequently in females especially if there is a tendency to genu valgum.

The original dislocation in either type is usually traumatic in origin. Reduction is at first most difficult and painful but after frequent recurrences it becomes exceedingly easy. The patient finds that by extending the leg and then flexing the thigh the kneecap can be manipulated into position. This procedure when often repeated eventually produces an unstable joint.

Effective treatment is surgical in nature. The operative procedure of choice depends upon the cause of the dislocation. See Soutter [illegible] operation, p [illegible]

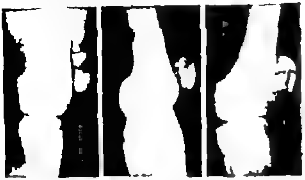


Fig. [illegible] Fig. [illegible] Fig. [illegible]
Fig. [illegible] Fracture of the patella with marked separation of the fragments.
Fig. [illegible] The fragments united with silver wire.
Fig. [illegible] Same patient [illegible] after [illegible] wire removed.

Fracture of the Patella

In fractured patella unsatisfactorily treated, the average result is fibrous union with varying functional loss, but even if bony union is obtained anatomic adjustment is often unsatisfactory and refracture is quite common, owing to the limitation of movement in a very active joint. Under such circumstances, open surgical treatment in the first instance is considered to be the treatment of choice (Figs. [illegible]).

Step [illegible] All the basic precautions applicable to aseptic surgery of the joints must be very strictly observed in the case of the knee joint as there is here strong tendency to infection with all of its calamitous sequences.

There are various incisions: straight, longitudinal or transverse; semilunar [illegible] or convex downward or convex outward or inward. The semilunar convex downward incision from the condyles of the femur nearly to the tibial tubercle seems to be preferred by most surgeons.

Step [illegible] Dissect the flap back until the ruptured capsule, ligaments and fracture fragments are exposed.

[illegible]

Step 3. Evacuate the knee joint; remove any blood clots. Separate the fragments and cleanse the joint cavity. The bone fragments are carefully lifted up and any fibrous tissue removed. Splinters of bone are frequently impaled in the torn fascia that prevents apposition of the fragments (Fig. [illegible]).

Step 4. With the leg extended, the bone fragments are rarely more than [illegible] inch apart. The surgeon must decide upon one of the many methods in vogue for uniting the bone fragments. These are principally: [illegible] "Cerclage" of the patella fragments with fascial bands, kangaroo or other tendon or wire (Fig. [illegible] p). This consists of exposing the bone and freeing it sufficiently. The suture selected is then made to encircle the fractured fragments. After this, the fibrous capsule, fascia and periosteum are sutured over the united patella followed by skin closure. [illegible] Transverse or longitudinal bone suture, holes being drilled in each fragment and using sutures of tendon, fascia, wire or silk. The holes must not penetrate into the joint. 3 Some cases, especially badly comminuted fractures, demand removal of the patella with the turning down of [illegible] flap of the quadriceps tendon to fill the defect.

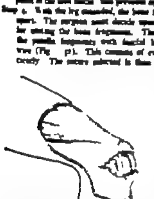


Fig. [illegible] Two [illegible] fractured patella showing [illegible] of bone [illegible] during operation. (After Hallbeck.)

Step 5. Following suture of the bony fragments, suture the lateral ligaments and other structures about the joints, repairing them as may be necessary.

Step 6. When the patient has recovered from the anesthesia, place [illegible] longitudinal padded posterior splint. This may be left in place for [illegible] week if the patient is an adult and can be trusted not to flex the leg after removal of the splint. For further treatment, Buck [illegible] extension or other splint or [illegible] permanent plaster cast may be applied for at least 4 weeks. Massage and passive and active movements may be commenced early. Good bony union is the rule and ankylosis is rare. Figure [illegible] depicts Barker's operation for fractured patella.

In old untreated or comminuted patellar fractures, the open surgical treatment is the same except that, following exposure of the fracture fragments, callus must be removed and the bone ends freshened. An Albee inlay bone transplant may be used advantageously to hold the fragments in approximation when the separation requires such [illegible] bridge.

[illegible] METHOD OF TREATING FRACTURE OF THE PATELLA

Two main factors must be kept in mind in treating these cases, according to Eugene St. Jacques. First, solid union and, second, mobilization of the knee joint after the operation, in order to prevent ankylosis.

Kangaroo tendons are used to maintain the apposition of the fragments, as

chromic catgut or silk will not insure solid apposition and prompt mobilization. When the latter materials are used for suturing the soft prepatellar tissues one must immobilize the knee for many weeks and then allow only very gradual movements. The suture material of choice is metallic-bronze-aluminum or so-called "metallic silk." This is pliable and unbreakable.

Operation

Step [illegible] A hole is bored from the upper edge of the upper fragment down through both fragments.

Step 2. Draw [illegible] double strand of the "metallic silk" through the holes.

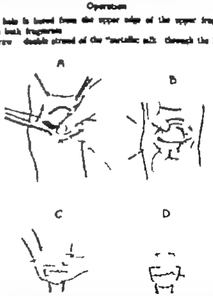


Fig. [illegible] Repair of fractured patella by tendons. Closure should be [illegible]. (After [illegible].)

Step 3. Draw each strand through the soft tissues, one to the left and one to the right, knotting the lower with the upper one of the outer side, repeating the same thing on the inner side—the fragments having been brought together and kept in juxtaposition with the aid of [illegible] proper bone clamp held by an assistant.

Step 4. A few catgut sutures complete the apposition of the soft parts—and an interdermal or silkworm-gut suture closes the skin. No drainage.

Comment. Before closing the patella or apposing its fragments the joint is filled up with Calot's Liquid (Creosote, 3 parts; Iodoform, 7 parts; Sulf. Ether, [illegible] parts; add to Olive Oil—sterilized—[illegible] parts)—this serves as an antiseptic medium, prevents adhesions and facilitates early movements.

Apply a posterior splint; replace it after 3 days by a simple bandage around the knee; begin flexion, gradually loosening the knee joint. On the 10th day permit the patient to walk around with a posterior splint; after a day or so, omit the splint and have him use a cane. St. Jacques used this method for 20 years with gratifying results.

GOWTHER OPERATION

This method gives good results when genu valgum is not present.

Step 1. Remove a strong eight-inch strip of fascia lata from the outer aspect of the thigh. Place the tissue in warm physiological saline and close the operative wound.

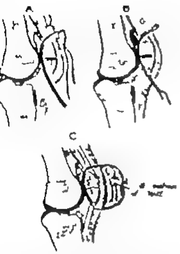


Fig. 1133. Barlow operation for luxated patella.

Step 2. Carry a vertical linear incision along the medial side of the patella down and over the median condyle of the tibia.

Step 3. Drill a hole through the patella from its midposteromedial aspect in a slightly anterior direction. With the leg extended make a drill hole through the medial femoral condyle on a level with that in the patella.

Step 4. Thread the fascial strip previously prepared through the holes and securely tie the free ends.

Step 5. Close the wound and dress. Immobilize the joint in a few degrees of flexion for six weeks.

ALBEE OPERATION

This procedure is frequently resorted to in the presence of genu valgum and lateral condyle deformities associated with recurrent dislocation.

Step 1. Carry a linear incision from above the lateral condyle forward and along the lateral border of the patella and thence backward below the tibial tuberosity.

Step 2. Expose the condyle; locate the anterior articular surface and one-half inch behind and three-quarters inch below it make a longitudinal incision with a 1-inch osteotome. Drive the instrument inward and upward, elevate the bone wedge thus loosened.

Step 3. Remove a slender wedge of bone from the crest of the tibia and snugly insert it into the wedge shaped defect created by the osteotome.

Step 4. Close the soft tissues and skin. Immobilize in a plaster of Paris cast for 4 or 5 weeks before passive motion is begun.

FRACTURES OF THE BONES OF THE LEG

The Report of the Committee on Fractures of the American Surgical Association, published in 1912, showed that about 20 per cent of fractures of the tibia and fibula are treated by open surgical operation. The Report states "In regard to operative treatment these (accompanying) tables appear to show that it has proved less easy to secure anatomical reposition of the fragments by operation at any age period than when no operation is done. The operated cases were not those in which non-operative methods had been tried and failed and had overriding displacement. In compound fractures only about one-fourth of the patients will secure good functional results unless accurate reduction is secured. In comparatively few cases can gross displacements of the leg bones be corrected by manipulation alone; such manipulations may do more damage to the soft parts than open operation." (Figs. 1134, 35, 36.)

Fractures of the Proximal End of the Tibia Alone or of the Tibia and Fibula Together

In closed fractures if there is wide separation of the tuberosities or if the knee joint is involved open surgical operation is indicated.

Step 1. A long incision is made over the fracture fragments. The knee joint is not opened.

Step 2. The displaced parts are dissected up and correction made both toward the joint surface and tibial edge. The fragments are maintained in position by nail or screw.

Step 3. Splints are applied for four weeks (Figs. 1137–1138).

Pott's or Dupuytren's Fracture

It is an established practice to reduce the fracture and immobilize it as quickly as possible (Fig. 1139). Reduction should be accomplished with the aid of x-ray checkups. General anesthesia is generally called for but spinal anesthesia is by some considered far superior. The method of reduction is as follows:

Step 1. Grasp the affected foot in the palm of the right hand. Place the foot at right angles to the leg. The object of this maneuver is to reduce the back and deformation.

Fig. 1134. Fig. 1135.

1134. Fracture of both bones of the leg.
Fig. 1135. Fracture of the tibia.

Fig. 1136. Reduction of a fracture of the leg.

Step 2. Bring the foot now in an exaggerated supinated position. In this manner one corrects the valgus resulting from the fracture. Hyper-correction in supinated position is warmly recommended by Bernstead.

3. Encase the limb in a plaster of Paris bandage.

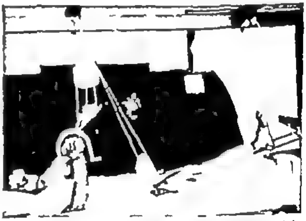


Fig. 1137. Fracture of both bones of the right forearm. Kirschner's wire through the radius and ulna. Also compound fracture of both bones of the right leg. Steinmann nail through the os calcis.

Fig. 1138. Fracture of both bones of the right leg and both bones of the forearm. Double pin fixation of the forearm. Steinmann nail through the os calcis.

Fig. 1139. Dupuytren's splint applied.

Open Fractures of the Leg Bones

are treated in accordance with the general rules governing the surgical treatment of open fractures anywhere. If reduction cannot be effected [illegible] nail through the heel bone, as previously described, should be used for skeletal traction.

Open surgical treatment of leg fractures is practically reserved to cases of malunion with overriding and shortening or nonunion following manipulative treatment.

Step 1. Make an incision over the site of the fracture, retract the muscles and expose the fracture ends.

Step 2. Removal of the fibrous tissue, [illegible] and freshening of the bone fragment ends are done. Skeletal or continuous traction will restore the proper length and the fragments are not attached in position with metal plates preferably applied on the lateral aspect of the tibia, where they can be covered with thick muscle and not immediately under the skin. Intramedullary [illegible] bone grafts may, of course, be used or any other method of osteosynthesis.

[illegible] Fracture of the [illegible] and fibula [illegible] ankle [illegible] with [illegible]

Step 3. Closure and immobilization.

Fracture Dislocation of Distal End of Fibula

If this dislocation cannot be reduced by manipulation, open surgical treatment is indicated (Figs. [illegible]).

Step [illegible]. Make [illegible] lateral incision over the lower end of the fibula and expose the bone by dissection.

Step 2. Any fibrous tissue interposed between the fibula and tibia is removed away and the fibula pressed close to the tibia. It is maintained in position by [illegible] into the tibia [illegible] and through [illegible] hole carefully drilled in the smaller bone.

Step 3. Repair any torn ligaments or [illegible].

Step 4. Close the skin wound and enclose the leg in [illegible] plaster cast.

Fracture Tearing the Head of the Fibula

In such [illegible] fracture the external popliteal nerve is often injured giving rise to acute pain. Manipulative reduction is very difficult and the indication is for open operation (Fig. [illegible]).

Step [illegible]. Make an external lateral incision in the line of the upper part of the fibula, retract the lacerated muscle fibers.

Step 2. A search [illegible] made for the external popliteal nerve, working from above downward and from behind forward keeping the tendon of the biceps [illegible] as [illegible] guide. When found the nerve is [illegible] and [illegible]

Step 3. The bone fragments are found, united and fixed by one or two sutures in such a way as not to again injure the nerve. It may be necessary

Fig. [illegible] Dislocation of ankle joint with fracture of tibia and fibula.

to excise the head of the fibula, rounding off the [illegible] end of the bone.

Malleolar Fractures

Malleolar fractures are generally treated by manipulative methods but in certain cases, as given below, open surgical operation is called for:

Fig. [illegible] Dislocation of ankle joint with fracture of fibula.

1. In irreducible tipping fractures.
2. When the tibio-fibular ligament is ruptured with wide separation of the bones. In such case it [illegible] necessary to nail the leg bones together to correct the position of the foot or to use skeletal traction by [illegible] nail or wire through the calcaneum.
3. In bi-malleolar and tipping fractures nothing of one or both malleoli in place is indicated. Old malunited fracture cases with deformity and [illegible] malfunctioning feet may necessitate surgical correction. An arthrodesis of the ankle joint is the usual method of choice. If pain is the greatest complaint and there is but little [illegible], [illegible] of [illegible] of the inner side of the fibula with [illegible] and [illegible] any [illegible]. This [illegible] of new bone formation on the inner

side of the fibula which requires [illegible] shape to accommodate the tibia and [illegible]. If there [illegible] much shortening an ankle arthrodesis may be carried out with insertion of [illegible] bone transplant to lock the talus to the tibia and fibula.

[illegible] the upper end [illegible] the tibia.

FRACTURES AND DISLOCATIONS OF THE BONES OF THE FOOT

FRACTURE OF TUBEROSITY OF OS CALCIS

This particular [illegible] of fracture requires surgical [illegible] (Fig. [illegible]). After reducing the fracture by manipulation make [illegible] small incision at the [illegible] of the posterior surface of the fragment of bone attached to the tendo Achillis. Drill [illegible] hole through this fragment penetrating the os calcis, and insert [illegible] bone peg. Suture the skin wound [illegible] necessary. Flex the knee and immobilize the extremity in [illegible] position of plantar flexion.

[illegible] and [illegible] recommend the formation of [illegible] flap of skin with its convexity turned upward which is built enough up the back of the ankle to escape friction from the hard part of the [illegible]. In cases of long standing one may have to resort to lengthening of the tendo Achillis before reduction can be accomplished.

Fracture of the Os Calcis

A [illegible] fracture of the os calcis which involves the [illegible] part of the bone is best treated by the open surgical method (Fig. [illegible]).

Step [illegible]. Make [illegible] vertical lateral incision [illegible] the leg flexed and the foot [illegible] extended.

Step [illegible]. The fracture area is opened up and the detached fragment is brought into contact [illegible] the fractured surface of the os calcis and fixed in position by lateral screws or other osteosynthetic methods. If necessary [illegible] wedge-shaped piece of the os calcis may have to be excised.

Step 3. Close the wound and immobilize.

[illegible] Fracture of os calcis treated by [illegible]

In avulsion fracture of the os calcis, open operation is indicated when there [illegible] much separation and displacement with [illegible] large detached fragment.

Step [illegible]. Make an incision about five inches long parallel to the inner margin of the tendo Achillis, carried down to the inner side of the heel. The skin and superficial parts are reflected.

Step 2. A tenotomy of the tendo Achill[illegible] done. The avulsed bone fragment [illegible] stretched down to the [illegible] of its former level. The bone surface of the body of the calcaneum is freed from clots or scraped [illegible] [illegible] instrument and the [illegible] bone fragment is held in place by absorbable [illegible] wires [illegible] through [illegible] into the body of the bone. Plantar flexion of the foot [illegible] necessary in order to obtain the approximation.

Fig. [illegible] "Y" shaped fracture of os calcis.

Step 3. If the bone fragment [illegible] large [illegible] may be affixed in [illegible] proper place by [illegible] screw or staple. Close the wound.

Step [illegible]. The foot, leg and thigh are placed in [illegible] plaster cast for six weeks and weight bearing is not allowed for about 12 weeks.

The same general surgical treatment is followed for any other kind [illegible] irreducible fracture of the os calcis [illegible] or if preferred, [illegible] nail

driven just above the calcaneum and beneath the tendo Achillis. A Kirschner wire may be used advantageously at times.

Old improperly treated compression fractures of the calcaneum may call for open surgical treatment owing to the constant pain and disability caused by walking or standing. The pain is due to the fact that the external malleolus is pressed down by weight bearing against the partly flattened calcaneum.

Step 1. A curved incision is made under and around the external malleolus. The skin and subcutaneous fat are retracted, the tendons pushed out of the way or cut and the calcaneum exposed.

Step 2. There is usually much callus and new irregular bone formation extending out and under the external malleolus. This is chiseled away and

Fig. [illegible] Fig. [illegible]
Fig. [illegible]. Transverse fracture through base of fifth metatarsal bone.
Fig. [illegible]. [illegible] fracture proximal phalanx [illegible] toe.

normal anatomic contour restored as far as possible. The wound is then closed, no effort being made in these old cases to restore the collapsed or compressed features of the fracture, it being expected that motion in such a foot will always be imperfect.

Magnuson's Method of Treating Fractures of the Os Calcis

Commenting on fractures of the os calcis, Paul B. Magnuson[1] states there is still considerable disagreement among authors as to the best method of treating this type of fracture. There is one fundamental rule and that is whatever treatment is decided upon must be rigorous and thorough because if the heel is not molded back into position properly serious and permanent disability ensues. Magnuson points out that since the tendo Achillis is attached to the posterior fragment of the os calcis transmitting the power of the gastrocnemius and soleus directly to this fragment, this pull must be relieved or disproved[?] [illegible] by putting the foot in full plantar flexion after the fracture has been reduced and doing a tenotomy on the tendo Achillis.

[1] [illegible], J. [illegible] Lippincott Company, [illegible]

Step 1. Do a tenotomy of the tendo Achillis. Place the inner and inferior surface of the os calcis across an orthopedic block. By means of a [illegible] mallet or a small hard sandbag the impaction is broken up by a few hard blows delivered to the lateral and superior surfaces of the affected bone.

Step 2. This having been accomplished the [illegible] is brought over the orthopedic block and the posterior fragment of the os calcis brought downward, outward and forward. They are then molded into as nearly normal contour as possible. Effect slight over-correction.

Step 3. Place a felt pad over the posterior and superior surface of the os calcis and over the dorsum of the foot and instep. The leg and foot are placed in a cast.

DISLOCATION AND FRACTURE OF THE TALUS (ASTRAGALUS)

An open surgical operation may be necessary to reduce a dislocation of the talus.

Step 1. Approach is made by an incision on the lateral aspect of the ankle. The peroneal tendon usually must be severed in order to expose the talus.

Step 2. The talus may be removed by flexing the foot laterally in order to permit its re-entrance into the ankle mortise. The general surgical rule is to remove the dislocated portion of the bone and leave the fragment which is in place in the ankle mortise. If this cannot be done the talus may have to be entirely removed and the foot put up at right angles to the leg or an immediate arthrodesis of the ankle done in order to obtain fusion.

Step 3. The peroneal tendon is sutured and the wound closed.

If the talus is fractured with an open wound, following the usual aseptic procedures for an open fracture, removal of the talus as above mentioned is usually the surgical method of choice. The same applies to other fractured bones in this vicinity.

DISLOCATIONS AND FRACTURES OF THE METATARSAL AND PHALANGEAL BONES

As a general rule these injuries are treated by special manipulative methods and no surgical operation is called for except in the case of open fractures. Such are very vulnerable to infection and gangrene and these must be guarded against, the fracture or dislocation being of secondary importance. (Figs. [illegible], [illegible].)

Step 1. Observe careful aseptic precautions, opening up and débridement are done, the foot being kept warm and circulation fostered.

Step 2. If there is pus, institute drainage.

Step 3. Avoid all weight-bearing. A plaster boot fitted with a metal stirrup is applied. This will relieve the sole of the foot from pressure and permit ambulation during the healing period.

Comment. Summarizing "Fractures of the Ankle and Foot," Frederick J. Cotton[2] points out the following:

[2] [illegible] to the New York and New England Association of Railway Surgeons, November, [illegible]

Class I. Outward Dislocation With Malleolar Fracture (Pott's fracture). This is readily recognizable even without x-ray (displacement; ease of reduction by inward pressure; impossibility of over-reduction). (Fig. [illegible].)

Later x-ray may call for modification of position before the foot goes into plaster, but often does not, and the advantages of immediate reduction are great, in the way of avoidance of swelling and formation of blebs.

For this and the next two classes, Cotton recommends the pillow splint scheme, as perfected by Curd[?] of Montreal.

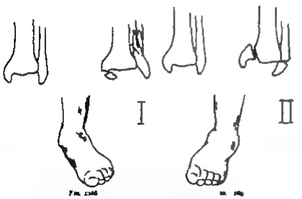


Fig. [illegible] Fig. [illegible]
Fig. [illegible]. Type [illegible] fracture with outward dislocation. Pott.
Fig. [illegible]. Type [illegible] Fracture with inward dislocation. Reversed Pott.

Class II. Inward Dislocation with Malleolar Fracture, Reversed Pott fracture. This fracture is produced by inversion of the foot. It can be reduced by pushing outward (not inward). This also cannot be over-reduced, and can be held. (Fig. [illegible].)

Treatment. Early reduction and immobilization. X-rays may be delayed if need be. Cotton points out:

"Oddly enough, the x-ray may lead to harm, not good, for this, like the Pott's fracture, involves breaking of both malleoli and, as it is not common enough to be familiar, confusion may arise. I have seen ghastly results in good hospitals from treating such cases by eversion.

"Class III. Backward Dislocation with Fracture (Cotton fracture). It involves fracture of both malleoli, with also a wedge off the back articular edge of the tibia, with displacement backward of the foot, malleoli and tibial fragment, all together. Here again the same principle holds—the

foot can be displaced back without resistance—cannot be carried forward beyond normal limits. (Fig. [illegible].)

"Treatment. Prompt reduction. This is especially indicated in these cases—not quite as easy as in Classes I and II, but it is usually necessary to swing the foot down, into plantar flexion before carrying it forward. If there is a carried over dorsal flexion, with the grip on the front part of the foot, it usually locks and can be put up in a pillow splint temporarily. In this injury the pillow splint is not usually permanent, nor even long continued, for the x-ray is apt to show slight displacement backward, recurring if replacement is done.

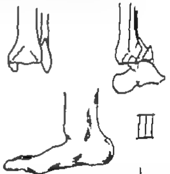


Fig. [illegible]. Type [illegible] Fracture with backward dislocation (Cotton fracture).

"There is much more tendency to redislocation in these cases than in those of Classes I and II. Occasionally there is a case encountered which can be treated only by open operation and pinning. (Fig. [illegible].) This is in definite contrast to the other varieties which practically never come to open interference except to correct old imperfect reductions.

Classification (Cotton)

I. Dislocation outward—Pott's.
II. Dislocation inward—Reversed Pott's.
III. Dislocation backward—Cotton.
IV. Dislocation upward (Tibial fracture, with or without fibular lesion)—Dupuytren. (Fig. [illegible].)"

SPRAINS

Disability resulting from slight or extensive rupture of the soft parts (ligaments and muscular attachments around the joint) resulting from forced action or direct trauma is known as sprain. One should never diagnose sprain without an x-ray check up. Many fractures without displacement effectively mimic

sprains (greenstick fractures, compression fracture of the os calcis, fractures of the malleoli, etc.)

Sprains of the Ankle Joint. Here the external ligament of the joint is usually ruptured. It is counteracted by promptly applying pressure over the ruptured ligament. Resort to adhesive plaster strapping, early massage, avoidance of the use of the affected limb for about [illegible] fortnight. The patient should not be permitted to wear an ordinary shoe without having it raised for three-fourths of an inch on its outer side in order to relax the injured external lateral ligament

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Operation for deformity [illegible] Above, [illegible] Below, [illegible]

Fig. [illegible] [illegible]

thus preventing union of its ruptured fibers. The raised shoe may be dispensed with toward the end of [illegible] month.

Sprain of the internal lateral ligament is usually accompanied by some form of Pott' fracture. Such injury should be treated by strapping the affected limb in [illegible] position of inversion. Here also before the patient is permitted to resume walking the shoe should be raised three-fourths of an inch of its inner border thus relieving the internal ligament and favoring union. The shoe must be worn about two or two and one-half months.

Sprains of the knee usually affect the internal lateral ligament which is partially ruptured. If the extent of the trauma is severe there may be [illegible] concomitant injury to the internal semilunar cartilage. The treatment consists of proper bandaging, early massage and absolute rest for about [illegible] week. Walking should not be allowed except in [illegible] shoe the inner border of which has been raised one-half inch.

In injury to the internal semilunar cartilage, the symptoms are more marked: besides pain, swelling and tenderness there may be [illegible] locking of the joint in partial flexion.

Check the findings by [illegible]-ray. The treatment consists of:

Reduction of the dislocated cartilage.
Immobilization of the affected joint.
3. Early massage.

In reducing the cartilage general anesthesia should be administered. Sir Robert Jones pointed out that the surgeon should be able to tell whether he finds the cartilage in its place or not.

To reduce [illegible] displaced cartilage the limb is put in abduction, flexion and external rotation followed by sudden adduction, internal rotation and extension.

Sprains of the Shoulder. Usually the parts injured here are the superior external portion of the capsule in the region of insertion of the flat tendon of the supraspinatus muscle. The subacromial bursa is also affected in which case Codman's bursitis is spoken of. The treatment is usually rest. Carry the affected arm in [illegible] sling without attempting to lift the arm from the side of the body. Use [illegible]—passive motion and active motion after the acute manifestations have subsided.

Sprains of the Elbow. Here ruptured muscle fibers, torn and displaced ligaments, formation of an adventitious bursa ([illegible], Osgood) may give rise to the so-called "tennis elbow." If the usual treatment fails, Osgood points out that there is an adventitious bursa of the painful spot, the ablation of which by partial dissection cures the condition. In recent cases, locate the painful area, rest the affected limb and apply gentle pressure.

In sprains of the wrist, adhesive strapping over the affected wrist should be carried on for some time.

Sprains of the Sacro-Iliac Joint. Rest, strapping and the wearing of sacro-iliac belt is advisable. In chronic cases general anesthesia may be administered with the patient in the reclining position the lower limb of the affected side flexed at the hip to [illegible] right angle with the knee extended and pressure [illegible] exerted downward on the pelvis. Then turn the patient to the side and hyper-extend the affected hip.

Part IV

SURGERY OF THE BREAST AND CHEST

ORIENTATION

Chapters 5 to 31 (incl.) deal with surgery of the breast, bronchi, pleura, lungs, the pulmonary artery, affections of the heart, of the mediastinum, pericardium, etc. While the surgical treatment of carcinoma of the breast is still buffeted about on the sea of surgical opinion, there is nevertheless a tendency toward stabilization. The more accurate classification of tumors of the breast (still far from complete) and understanding of the indications and types of surgical procedures suitable for specific cases, have considerably clarified and standardized operative procedures. These are being referred to in connection with the operations described. Frozen sections at the operating table for the purpose of ascertaining the presence or absence of malignancy have frequently yielded erroneous information. The contributions of Handley and Halsted are still the guiding posts to many, while others abstain from "cleaning out the axilla," arguing that carcinoma is a systemic and not a local disease. Radiation therapy and electrosurgical procedures as palliative, alone, or in combination have their place. Radiation as a pre- and postoperative measure is of value in the hands of the surgeon who evaluates, dovetails and combines to fit the formula represented by the varied conditions of the patient.

Lilienthal, Sauerbruch, Nissen, Churchill, Archibald, Rienhoff, J. Graham and others have done much to throw light onto the problems confronting the surgeon in chest surgery. A thorough perusal of the operative procedures described in this chapter will point out the remarkable results achieved in the last decade or two, the result of these contributions. Unfortunately pulmonary embolus is still the bête noir in surgical practice. Some progress has been made in these tragic situations, the result of the corner stone built by Trendelenburg and furthered by the contributions of Willy Meyer, Howard Lilienthal, Elliott C. Cutler, Gunnar Nyström and others.

The surgical treatment of pulmonary tuberculosis has made rapid strides.

Unfortunately, the lack of serous investment of the thoracic esophagus is still a vulnerable point and is responsible for a dark chapter in surgery despite the fine contributions of Torek, Lilienthal, Grey Turner and others. Much remains to be done here. However, it is stimulating to contemplate that while a few decades ago surgery of the heart was an [illegible] [illegible], real progress is in the making. To mention only Claude S. Beck's contributions to the surgery of the heart (suture, resection of the pericardium, attempts at creating a new blood supply to the myocardium, etc.) and the admirably conducted researches in other quarters is sufficient.

CHAPTER 23

SURGERY OF THE BREAST

Anatomic Considerations. The breasts consist of parenchyma, stroma, and adipose tissue (Fig. [illegible]).

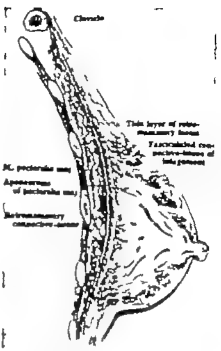


Fig. [illegible] Gross anatomy of the female breast. Longitudinal section.

Arteries. The first, second, third and fourth perforating branches of the internal mammary artery, the long thoracic, the pectoral branch of the acromiothoracic, the superior branches of the axillary artery, the perforating branches of the internal mammary artery and branches from the subscapular artery (Fig. [illegible]) extending from the inner side from the second to the sixth rib.

Veins. The veins correspond to the arteries. The veins anastomosing around the nipple are known as the circle of Haller.

Nerves. Intercostal, thoracodorsal, long thoracic, descending cutaneous branches of the cervical plexus and branches from the brachial plexus.

Lymphatics (Fig. [illegible]). There are two sets of lymph nodes, superficial and deep. The deep lymphatics lie within the interlobular connective tissue forming plexus around the mammary lobules. They follow the course of ducts and converge upon the surface beneath the areola where they enter the subareolar plexus of Sappey. In addition this plexus receives cutaneous lymphatics from the nipple and areola. The deep lymphatics also communicate with the pectoral plexus, situated beneath the pectoral fascia. From the pectoral and subareolar plexus the lymphatics course outward forming several large trunks which terminate in the pectoral group of the axillary nodes. From the inner side of the breast a few lymphatic trunks course along the anterior perforating arteries and terminate in the anterior mediastinal lymph nodes. From the upper part of the mamma they terminate in the subclavicular group of nodes after perforating the costo-coracoid membrane. There are a few intercommunications between the lymph channels of the axilla and the pectoral plexus also communicate through the upper part of the anterior abdominal wall with the subperitoneal plexus of the abdomen.

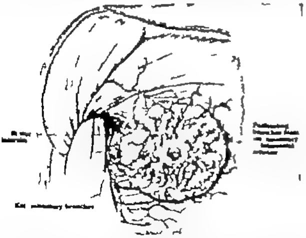


Fig. [illegible] Arterial supply of the breast.

The Relation of the Lymph Nodes of the Subclavicular Fossa to Cancer of the Breast is discussed by Caryannopoulos (Athens, Greece) and Henri Godard (L'Ouest Scientifique) and Professor Pierre Delbet. They point out that in certain cancers of the breast one finds an involvement of the supraclavicular lymph nodes in cases in which the axillary nodes are not involved. In these cases, metastasis has taken place along a different route than that commonly observed when the axilla is involved before the supraclavicular

fossa is invaded. These facts led Delbet to advise his pupil Pierre Marcard to make a detailed study of the lymphatics of the breast. Using Gerota's method, Marcard injected one hundred mammary glands in [illegible] to [illegible] month fetuses and children one to two years old. A study of these specimens led him to distinguish [illegible] distinct types of lymphatic drainage.

In Type I (classical type) the lymphatics empty into the lymph nodes of the axilla following the lower border of the pectoralis major muscle between the breast and the axilla. There may exist a paramammary node which is intercalated. This classical type Marcard met in only [illegible] per cent of the cases.

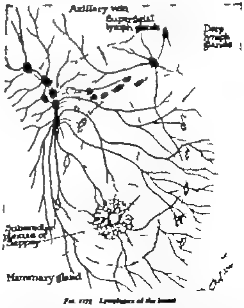


Fig. [illegible] Lymphatics of the breast.

In Type II Marcard injected more external efferent lymphatic vessels which followed the lower border of the pectoralis major and emptied into [illegible] lymphatic nodes, [illegible] cases.

In Type III the mammary gland has two lymphatic pedicles: first, the classical axillary pedicle; second, a direct supraclavicular pedicle formed by two or three vessels arising from the superior internal portion of the mammary gland and passing beneath the pectoralis major muscle near its costal insertion and emptying into the supraclavicular nodes without passing the axilla.

Type IV is [illegible] variant of Type III. It differs from it in that the lymphatics of the clavicular pedicle pass between the two pectoral muscles instead of passing beneath the pectoralis major.

In Type V the lymphatics of the clavicular pedicle empty directly into the lymphatic nodes found above the clavicle. These vessels pass under the pectoralis major between the subclavius muscle and the subclavian vein and empty into the node at the confluence of the jugular and subclavian veins. The supraclavicular nodes are divided into two groups—an external and an internal. The latter group is situated by the [illegible], the most [illegible] node of this group lying at the angle formed by the internal jugular and subclavian veins. The external group is situated upon the anterior surface of the brachial plexus between the subclavian artery and the omohyoid muscle. It [illegible] the efferents [illegible] from the axilla.

Type VI. This is the internal mammary pedicle. The lymphatics pass through the thoracic wall from in front backward and empty into the sternal nodes (second, third and fourth intercostal spaces). These nodes are practically inaccessible. Happily this lymphatic path [illegible] of only minor importance. [illegible] succeeded in injecting it only [illegible] times out of one hundred.

From the clinical viewpoint, [illegible] is important to seek carefully for supraclavicular adenopathies. To explore the supraclavicular fossa, stand behind the patient who holds her head straight and immobile. Explore simultaneously the two sides by placing the index fingers in the angle formed by the sternomastoid muscle and the clavicle. The node is at the confluence of the jugular and subclavian veins. Do not mistake the anterior belly of the omohyoid muscle for [illegible] lymph node. This can be avoided by having the patient swallow. You can then feel the muscle contracting and relaxing. Continue the exploration laterally as far as the trapezius muscle. At times, one feels the chain of lymph nodes along the external jugular vein and at times along the border of the trapezius muscle. The primary clearing of the supraclavicular fossa [illegible] done at the same time as the amputation of the breast. It was performed seventy-one times. In [illegible] cases the nodes were clinically palpable. In four of these cases the nodes were not involved. In the other twelve they were cancerous. In [illegible] second group of cases the supraclavicular nodes though not palpable clinically were found cancerous in three cases out of fifty five. In study on postoperative neoplastic recurrences, it seemed that recurrence took place at the supraclavicular nodes. In all cases in which the cancer is situated in the superior medial part of the breast, the supraclavicular fossa must be cleared. The authors recommend the following technic for the clearing of the supraclavicular fossa.

CLEARING THE SUPRACLAVICULAR FOSSA

The apex of the incision should correspond to the clavicular extremity of the sternomastoid muscle. The triangular flap, having its base at the trapezius, includes the platysma myoides muscle and external jugular vein. The middle cervical fascia stretched by the omohyoid is exposed. It is there the nodes are found and they must be removed. Cut the omohyoid at the level of the internal jugular vein and remove the nodes following along that vessel. If the node at the confluence of the jugular and subclavian veins [illegible] should be removed with the finger. If adherent, better not to proceed further. *Suture without drainage.*

Results. The operation was performed in seventy-two cases. There were three deaths, one due to cardiac complications, the others to [illegible]. There [illegible] frequent complications of lymphorrhagia. It occurred in an open wound probably to injury of the right lymphatic duct or of the thoracic duct. It is preferable not to ligate these vessels even if they be wounded. [illegible] edema they develop, it will not be permanent if the permeability of the vessels [illegible] preserved. The lymphorrhagia may last from two to three weeks. *This step is anatomically and clinically justifiable.* It enables us to cure [illegible] few cases formerly considered inoperable and abandoned to fate.

OPERATIONS FOR MAMMARY ABSCESS

Abscesses arising in connection with the breast are of three types, viz:

The Premammary or *Subcutaneous Abscess*
Mammary Abscess Proper and
3. Retromammary Abscess in the areolar tissue separating the breast from the pectoral fascia.

PREMAMMARY ABSCESS

Make [illegible] liberal radial incision, evacuate the pus, and drain with dental rubber or [illegible] cigarette drain.

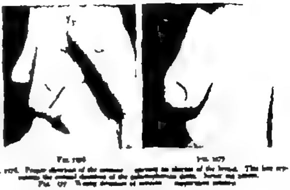


Fig. 1176 Fig. 1177

Fig. 1176. [illegible] of the [illegible] of the breast. The [illegible] [illegible].
Fig. 1177. [illegible]

MAMMARY ABSCESS

This is often multiple. Fibrous partitions from the stroma of the breast dividing individual pus pockets.

Step [illegible] Make an incision radiating from the nipple [illegible] transversely across (Figs. 1176-1177). The incision must not encroach upon the areolar tissues (injury to an areolar [illegible] or [illegible] duct [illegible]).

Step [illegible] Introduce [illegible] finger into the pus pockets and break down septa which might interfere with effective drainage.

Step 3. Introduce cigarette drains or strips of dental rubber into the evacuated pus pockets.

Step 4. Counter drain at the periphery of the infected area if deemed necessary (Fig. 1178.)

RETROMAMMARY ABSCESS

Step [illegible] *Make an incision in line with the thoraco-mammary fold (Fig. [illegible].)* Deepen the incision until the deep fascia is reached, define the lower edge of the breast and enter the space occupied by the retromammary abscess.

Step [illegible] Drain. If there is [illegible] connecting the abscess and source of infection, incise it and excise it. The wall of the abscess cavity may be gently curetted. Drain.

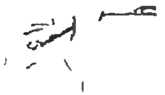


Fig. [illegible]

Fig. [illegible]

Fig. 1178. Abscess [illegible] the breast. Incision has been made at the anterior part of the breast and [illegible] the mammary fold [illegible] [illegible].
Fig. 1179. Drainage [illegible] abscess. After the [illegible] has been made with the scalpel the [illegible] completed with [illegible].

OPERATIONS FOR TUMORS AND CYSTS OF THE BREAST

TUMOR OR CYST LOCATED IN THE SUPERFICIAL PORTIONS OF THE BREAST

Local anesthesia may be used. (Figs. [illegible].)

Step [illegible] Expose the tumor through [illegible] radiating incision placed directly over the neoplasm.

Step 2. Clear the tumor of overlying breast tissue by careful dissection and enucleate it.

Step 3. Obliterate the dead space resulting from the removal of the tumor with interrupted catgut sutures which approximate the remaining healthy tissue.

Step 4. Close the skin (Michel clips [illegible] subcuticular silk suture).

Fig. [illegible]. Position of patient on the operating table showing the draping of [illegible] and [illegible] of the area of operation [illegible] the breast and [illegible].

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. [illegible] removal of [illegible] breast tumor. A diamond shaped area embracing the portion of the breast involved [illegible] [illegible] [illegible] [illegible] [illegible].

TUMORS OCCUPYING DEEPER PORTIONS OF THE BREAST

Step 1. A Gaillard-Thomas premammary incision is used (Fig. [illegible]). This is [illegible] curved incision in the thoraco-mammary fold beginning at the nipple line and extending to the anterior axillary border.

Step 2. Separate the posterior surface of the breast from the pectoral fascia exposing the portion of breast overlying the tumor.

FIG. [illegible]. Gaillard-Thomas [illegible] incision in the thoraco-mammary fold.

Step 3. Incise the breast tumor and shell out the tumor.
Step 4. Obliterate the resulting space by interrupted catgut sutures.
Step 5. Close the skin. Drain.

FIG. [illegible]. Conservative removal of the breast. The [illegible] shown is begun by submammary [illegible] the [illegible].

SINGLE CYSTS

Here the steps are similar to the preceding. The cyst walls often offer difficulties during enucleation, and the cyst is almost invariably broken. For that reason it is best to excise a wedge-shaped segment of breast tissue carrying out the cyst.

MULTIPLE CYSTS (POLYCYSTIC DISEASE)

The entire breast may be excised. Where conservative removal of the whole breast is contemplated, [illegible] may be used (Fig. [illegible]).

Step 1. Make [illegible] Gaillard-Thomas incision as before.
Step [illegible]. Dissect the breast free from the pectoral fascia and from the overlying skin. Divide the ducts as they enter the nipple.
Step 3. Insure hemostasis. Allow the superimposed skin to fall back over the

large wound resulting from the removal of the breast. Suture the skin into place, after cutting away redundancy.
Step 4. Drain where indicated. Dress.

PLASTIC OPERATIONS ON THE BREASTS

PENDULOUS BREASTS (MASTOPTOSIS)

Unfortunately the term "plastic surgery" was forced by quacks into disrepute in the ranks of ethical surgeons, for a number of decades. The thought is

FIG. [illegible]. Virginal hypertrophy of the breasts.

stimulating, however, that on the European continent, serious-minded surgeons through an education campaign, encouraged research and enlightenment in this direction. In this country the Society of Plastic and Reconstructive Surgery and the creation of chairs for the teaching of plastic surgery in various universities have done much to develop this branch of surgical endeavor.

A brief review of the history of this phase of surgical work may not be amiss in this connection.

Durston, in [illegible], was first to describe the clinical entity now known as hypertrophy of the breast and mastoptosis. Nearly a century of silence prevailed in the literature until Velpeau in [illegible] and Labarthe contemporaneously studied

the subject anew. In [illegible] Michel and Pousson excised the upper half of the breast, making a half moon shaped excision, beginning at the axilla and extending to the sternum in a case of double hypertrophy of the breast in a young woman. Verchère followed suit in [illegible] but excised a lateral triangular section of the breast.

In April, [illegible] I reported my experiences and results in free transplantation of the nipple and areola supplemented by resection of the hypertrophied breast before the North Shore branch of the Chicago Medical Society and published a paper on the subject in November of [illegible]. In [illegible] Lotsch reported that he elevated and resected the breasts through a longitudinal skin incision above and below the mamma. In [illegible] Hollander combined the methods of Pousson and Verchère. In [illegible] (March [illegible]) Passot, and on the [illegible]th of March of the same year Dufourmentel reported on the subcutaneous transposition of the nipple. In [illegible] Joseph published his case of mammaplasty which he performed in [illegible] by double wedge-shaped excisions of the breast with the retention of a bridge of skin to assure nutrition to the nipple. In the same year Lexer and Kraske, and in [illegible] Axhausen described plastic resections of the hypertrophied breast.

In [illegible] Joseph described his two-stage, and later in the same year, his three-stage operations. In [illegible] Biesenberger published his plastic operations with surgical torsion of the breast and in [illegible] Schwarzmann elaborated on the Joseph technic.

Erna Glässmer of Heidelberg resected, in [illegible], lateral and supramammary sections of skin and breast tissue and thus endeavored to diminish the size of the breast and accomplish an elevation.

Dartigues and others added refinements of technic of some type or another.

Patients seek relief from these disabling conditions because they interfere with their earning livelihood; some even develop psychoses from brooding over their disability. In others, where the condition is less pronounced, esthetic and [illegible] reasons force the patients to seek surgical relief (Fig. [illegible]).

Careful individualization and planning of the operation are necessary to obtain satisfactory results although a great deal depends on the experience and skill of the surgeon as well as the cooperation of the patient in the pre- and postoperative care. While many successful cases are reported at the hands of the experienced operator, numerous unrecorded failures are attributed to the inexpert in plastic procedures. Lack of knowledge of the subject, improperly selected cases, inadequate pre- and postoperative care may result in sloughing, abscess formation and even loss of life.

The great multiplicity of operations suggested for the correction of hypertrophic breasts has thus far failed to yield a standard technic. Complicated procedures, such as transpositions of the nipple, two, three, and even four stage operations, partial resection with total torsion of the remaining mammary substance and numerous other complicated procedures, capable of yielding good results in the hands of the originators of the respective method, create a chaotic situation, extremely perplexing to the surgeon who asks, "Which is the simplest method giving uniformly good results?"

After a number of years of experience with most of the methods advocated, I have concluded that good results are obtainable and depend upon the simplest

[illegible] New York Med. J. [illegible]

possible technic, absolute asepsis, a thorough knowledge of anatomy and meticulous attention to detail.

Distressing effects of hypertrophy of the breasts may be grouped as follows:

1. Physical manifestations.
2. Vocational incapacity.
3. Esthetic drawbacks.
4. Psychic influences.

Physical Manifestations. The excessive size of the breast may cause a considerable degree of discomfort (pulling, dragging sensations, intensified at the menstrual period) referred to as mastodynia by Girard. Circulatory disturbances have been described by Velpeau and in rare cases by Kraske (edema, discoloration, even ulcerations). Intertriginous eczema is not infrequently encountered, particularly in hot weather (*eczema intertrigo*). Extremely pendulous breasts are followed by untoward influences on the heart and lungs. The dragging breasts cause alterations in the vertebral column which may, in aggravated cases, lead to a greater or lesser degree of kyphosis.

Vocational Incapacity. In this group belong dancers, public speakers and people of the stage, artists' models (an important vocation in modern times), and those engaged in swimming, tennis, etc. (Figs. [illegible]).

Esthetic Drawbacks. Women of refined esthetic taste are hypersensitive of pendulous breasts.

Psychic Influences. Inferiority complexes, neuroses and psychoses may develop. Tendencies to suicide and actual attempts at self-destruction have been reported (Axhausen).

A rather exhaustive study of the more or less complicated methods of Lotsch, Erlacher, Kraske, Kausch, Lexer-Kraske, Hollander, Joseph and particularly that of Biesenberger has convinced me it is best to abandon any procedure which is difficult to perform and offers greater possibilities of failure than the simple method of resection of the breast with free transplantation of the nipple which I have devised.

Summary. Patients often seek relief from excessively hypertrophied breasts and the train of symptoms accompanying the condition.

Surgeons desiring to relieve these patients should acquaint themselves thoroughly with the anatomicopathologic factors underlying the abnormality and the methods for their relief.

3. Good results usually follow properly executed operations but it must be remembered that numerous attempts at breast plastics have been followed by necrosis of the nipple, necrosis of the breast tissue and suppurative conditions and their sequelae.

4. The more exact the technic the better the results.

5. Patients should be told that the transplantation, though not interfering, of the nipple precludes lactation.

6. When the pendulosity is moderate a transposition operation may be carried out successfully.

Principally the operative procedures for reconstruction of pendulous breasts may be divided into

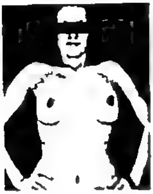
Operations with transposition of the nipple

The author[illegible] operation of resection of the breast with transplantation of the nipple

Resection of the Breast and Transposition of the Nipple

Step 1. Circumscribe the nipple. Make an incision above the nipple as shown in Fig. [illegible] ( ). A retromammary incision supplements the latter.

Step 2. At [illegible] higher level, cut out an oval area to receive the transposed nipple. Dissect away the skin. (Fig. [illegible] ( ).)



[illegible]

Fig. [illegible] [illegible]

Fig. [illegible] [illegible]

Fig. [illegible] Same patient [illegible] weeks after operation [illegible]

Step 3. Undermine the skin overlying the superior segment of the breast. (Fig. [illegible] ( ).)

Step 4. Introduce [illegible] long forceps through the circular opening made. Grasp the nipple and pull [illegible] into its new site. (Fig. [illegible] (4).) Suture [illegible] in place.

Step 5. Resect the redundant part of the breast. (Fig. [illegible] (5).)

Step 6. Suture the flaps of skin together as shown in Fig. [illegible] (6).

Author's Operation of Resection of the Breast and Transplantation of the Nipple

Step [illegible] Make [illegible] supra-areolar convex incision anteriorly over the hypertrophied and pendulous gland. [illegible] second, similarly directed incision beneath the gland [illegible]

Step 2. Between these two incisions remove as much of glandular and adipose tissue as [illegible] deemed necessary to obtain the desired size and contour.

Step 3. Detach the nipple and areola completely through [illegible] free, circular incision. The subdermal tissues of the nipple must be treated with utmost gentleness.

Step 4. Transplant the detached nipple into [illegible] circular bed prepared at the site previously selected.

Surgical artistry and special technical skill are requisite for these procedures if one [illegible] to obtain [illegible] well formed new breast-contour and to avoid unsightly lumps and disfiguring scars.

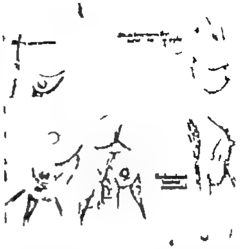


Fig. [illegible] Transplantation of nipple with resection of the breast. Two-stage operation.

In the great majority of my cases thus treated there was clinical evidence of good cosmetic result and there was no doubt regarding the viability of the freely transplanted tissue. However [illegible] was not until recently that I had the opportunity of obtaining complete histological verification of this statement.

In [illegible], [illegible] woman on [illegible] I had performed [illegible] plastic operation on the breasts, including nipple transplantation, again came under my care two months later. With the patient's consent [illegible] small section of the transplanted nipple was removed for biopsy (Fig. [illegible]). The epithelium was found intact; the corium contained round cells with [illegible] few polymorphonuclears and some plasma cells. There was no isolated islet of epithelial cells. In all probability this was due to implantation, the result of pinching off some of these cells during the process of operative transplantation.

Following the acute inflammatory process, this stage passes to the subacute phase as [illegible] evidenced by some of the polymorphonuclear and [illegible] more extensive

Fig. [illegible] [illegible] of the nipple. High power magnification [illegible] [illegible] [illegible] round cells. [illegible] few polymorphonuclears and some plasma cells are seen.

Fig. [illegible]

Fig. [illegible] Pendulous hypertrophic breasts before operation.

Fig. [illegible] Same [illegible] weeks after author's operation.

round cell infiltration. When this area is examined under high power the epithelial strata are found intact and immediately below this area, in the corium,

there are many round cells, plasma cells and some scattered polymorphonuclear leukocytes. This is seen to even greater advantage [illegible] higher magnification of the corium is examined. Here the cellular elements and the capillaries in the corium may be clearly studied.

From these findings, it is quite evident that the transplanted nipple and areola have become vascularized and incorporated in the new site as normal, living tissue. They further show that the operation of resection of superfluous tissue in hypertrophied pendulous female breasts, with free transplantation of the nipple and areola, is [illegible] practical one, and that, [illegible] carried out with proper technic, the result will not only give relief of the patient's [illegible] disability but also be satisfactory from the esthetic point of view (Figs. [illegible]). The transplanted

Fig. [illegible]

Fig. [illegible]

Fig. [illegible] [illegible] separation of the superficial layers of the skin revealing the healed nipple underneath.

Fig. [illegible] Close-up of transplanted nipple [illegible] weeks after operation showing [illegible] [illegible] leaving the healed nipple structure united to the breast.

nipple does not become absorbed or die but continues as normal, vascularized, living tissue in the vast majority of cases.

In [illegible] properly performed operation, as I have outlined, the surgeon must not concede failure if the surface of the nipple appears dark to even black in color [illegible] few days following transplantation. This does not signify failure of the nipple to take; on the contrary, in most, if not all, of the cases where the technic has been faultless and the postoperative care proper, the superficial, discolored layer representing only the [illegible] stratum corneum, exfoliates, while the cutis vera goes on healing by primary intention (Figs. [illegible]). It may take from [illegible] to [illegible] weeks for the stratum corneum to separate. This, however, does not hinder the patient from pursuing her usual vocation. The keynote to the postoperative treatment consists of dry asepsis (dusting powder and sterile supportive dressings).

INVERTED NIPPLE

(Sellheim Operation)

Figures 195–196 depict the condition and the principles underlying this procedure. Careful outlining of the proposed procedure prior to operation and careful operating are essential.

Step 1. Measurements are made of the component parts of the area as outlined (A and B).

Fig. 195. [illegible]

Step 2. Three small incisions above and three below the nipple and two larger lateral incisions are made (C).

Step 3. A ligature of silk pulls the inverted nipple out. The flaps are dissected as shown in the illustration D.

Fig. 194. Inverted nipple.

Step 4. (E) Triangular flaps are snipped away at the site of the smaller incisions.

Step 5. (F-H) The triangular areas are united with fine, interrupted silk sutures.

Step 6. Michel clips finish the procedure (I).

OPERATIONS FOR CARCINOMA OF THE BREAST

Historical Notes. Aetylius operated for carcinoma of the breast as early as the third century. The breast was grasped with crude ... of forceps, ... with the sweep of ... large sharp knife and the surface resulting seared with the cautery. Benjamin Bell (1802) insisted on thorough removal of the axillary glands and pectoralis muscle. Sir Astley Cooper pointed out the importance of wide removal of the skin and lymph channels, whether involved or free. Charles Moore (1867) insisted on block resection of the entire breast (skin, fat, pectoral fascia,

muscles and lymph nodes). Sir Mitchell Banks (1882) taught the removal of axillary glands whether they be palpable or not. Volkmann (1875) removed the fascia of the pectoralis major in every case. Halsted (1889) practiced the routine removal of the pectoralis major as advocated by Sir Mitchell Banks in 1867. Willy Meyer (1894) removed both pectoral muscles. Handley (1904) was a strong advocate of removing the fascia covering the inner border of the opposite pectoral muscle, the upper portions of the rectus muscles, external oblique and latissimus dorsi. Modern methods include the beneficial effects of early diagnosis, deep radiation and radium.

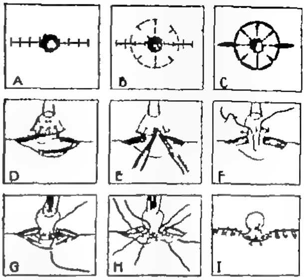


Fig. 196. Sellheim operation for inverted nipple. For explanation see text.

The modern aim of the operation consists of the removal of:

1. A sufficiently large skin area including the nipple and tegmenta overlying the tumor.
2. Sufficient subcutaneous tissue covering the chest wall and the tumor area forming the *center of the subcutaneous tissues removed*.
3. Both pectoral muscles except a small part of the larger muscle (see below).
4. The fascial structures of the lateral chest and upper abdominal regions.
5. The lymph structures concerned.

OPERATION

Preparation of the Patient. When carcinoma is suspected, do not delay operating in order to "build up" the patient. The area to be operated on must

be prepared thoroughly with soap and water, the axilla shaved and a mild antiseptic applied overnight. Immediately before the operation the surface should be painted with iodine, the arm draped and placed in proper position (Fig. 197).

Do not neglect to have x-rays made of the mediastinum, vertebral column and other suspicious areas. In some cases these areas are affected by early metastases, and *if such be the case no operation should be undertaken.*

Anesthesia. *This depends upon the condition of the patient and the preference of the surgeon.* Nitrous oxide oxygen, when given by an expert is the anesthetic of choice. Ether when no contraindications exist, serves well. When electrosurgery is used for the removal of the breast, caution should be observed with ether and ethylene should never be used.

Incision. Numerous skin incisions have been advocated. The incision *shown in Fig. 198 will suffice for all intents and purposes.* It may be extended and modified to meet the special needs of a given case. Ample exposure and thorough anatomic dissection are essentials. (Fig. 198 b.)

Fig. 197. Position of arm at operation on the breast involving the axilla.

Position of the Patient. Dorsal decubitus with a pillow between the shoulders. The arm, with the elbow flexed upward, should be placed at right angles with the body. Avoid pressure on the musculo-spiral nerve. Do not abduct the arm too forcibly, this causes displacement of the axillary vein exposing it to injury.

Step 1. The skin along the entire margin of the incision is dissected up from the underlying tissues to an extent shown in Fig. 198 b, viz. the flaps extend as far as the sternum in the midline and to the posterior axillary fold laterally. Expose the pectoral fascia to the line of the upper incision. Lift the skin and cut off the muscle until the furrow is reached that marks the dividing line between the sternocostal and clavicular portions of the pectoralis major muscle.

Step 2. With the back of the scalpel separate the muscular fibers of the greater pectoral muscle almost as far as its humeral attachment. Retract the arm thoroughly. Divide the muscle at its humeral insertion. Now separate the muscle with the fascia lying above and below it from its attachments and connections with the chest wall. The perforating branches of the internal mammary artery are now cut through. Ligate these. The entire mass (sterno-costal part of the pectoralis major muscle and mammary gland) is dissected away from the ribs and intercostal muscles and displaced laterally.

(Fig. 198 c). In this dissection set the knife flat thus avoiding injury to the intercostal muscles and pleura during the detachment of the mass.

The costo-coracoid membrane, the pectoralis minor muscle and the upper portion of the axilla are now fully exposed.

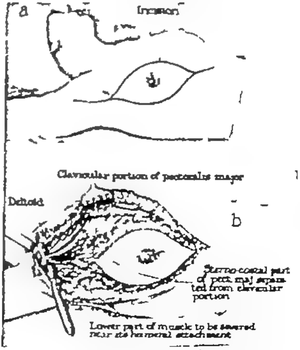
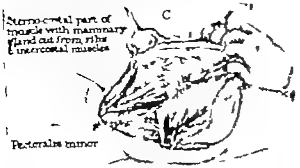


Fig. 198. Radical amputation of the breast.

Step 3. The pectoralis minor, it will be remembered, is inserted into the coracoid process of the scapula. Expose the outer edge of the pectoralis minor in its entirety. In advanced cases of carcinoma the small pectoral muscle must also be removed (Fig. 198 d). Expose the free edge of the latissimus dorsi muscle. Lift the gland off the interdigitations of the serratus magnus.

The gland and major pectoral muscle are now attached by connective tissue and axillary fat only.

Step 4. Cleaning out the axilla. Expose the axillary vein (Figs. [illegible]). It is seen showing through the fascia. Do not tear through the fascia, rather incise the clavicoraco-axillary fascia along the line of the coraco-brachialis



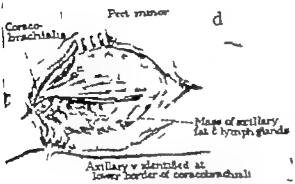
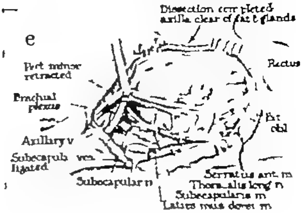


FIG. [illegible] (continued). Radical amputation of the breast.

muscle up to the insertion of the pectoralis minor muscle. Hook a finger under this muscle and divide it, or the muscle may be retracted laterally if it is decided to leave it behind (Fig. [illegible]). Catch the fascia with an artery forceps and retract it toward the chest. Strip the fascia forward across the

axillary vessels. The upper edge of the clavicoraco-axillary fascia is thus lowered and the vessels thoroughly exposed. The axillary vein is usually a large single trunk but often found as two branches (Figs. [illegible]). The



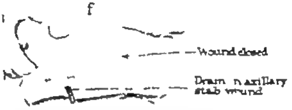


FIG. [illegible] (continued). Radical amputation of the breast.

vein is superficial to the nerves and other vessels of the axilla. The nerves of the brachial plexus surround the axillary vein. A number of tributary veins enter from the axillary fat. The largest and most important of these is the subscapular vein. This accompanies the subscapular artery.

Ligate and divide all tributary vessels in this locality; this is to go hand in hand with the removal of all fat, lymph nodes and other cellular elements

This must be accomplished with care and exactitude. Blunt and sharp dissection carefully carried out accomplishes this. The axillary fascia should be separated from the brachial fascia. This permits the reflection forward of the anterior lateral wall of the axilla. Incise the fascia on the under surface of the latissimus dorsi, free it from the anterior border and then from the anterior surface of the muscle up to the anterior border of the subscapularis. The subscapular fascia is now freed (Fig. [illegible]).

If at all possible, preserve the important nerves springing from the brachial plexus. Respect the subscapulars and long thoracic nerves. The latter is also known as the respiratory nerve of Bell (Fig. [illegible]). The subscapular nerve is found in the proximity of the subscapular vein and supplies the subscapularis, teres major and latissimus dorsi muscles. The thoracic longus (Bell nerve) emerging from under the pectoralis minor muscle runs longitudinally along the wall of the thorax and supplies the serratus magnus muscle.

[illegible]. Radical amputation of the breast. Preserving the long thoracic nerve completely lateral dissection of the axilla [illegible] the axillary [illegible] pectoralis [illegible]. Axillary fascia, pectoral muscle and breast [illegible]. Long subscapular nerve. Subscapularis muscle. Latissimus muscle. Long thoracic nerve. Serratus muscle. [illegible]

A thorough cleaning out of the axillary space should leave it absolutely clean, nothing remaining behind but the bare muscle, the subscapulars and long thoracic nerves.

Some begin the dissection of the axilla from above downward and vice versa.

When the malignant mass involves the lower and outer margin of the breast implicating the subscapular chain of glands, the subscapular nerve will have to be sacrificed. Gauze dissection is often effective in cleaning out the axillary space when not extensively involved. The nearer the primary tumor approaches the axillary margin of the breast, the further back it becomes necessary to remove the fat and fascia, beyond the edge of the latissimus dorsi. Whether the pectoralis minor is to be sacrificed or not depends, as already stated, upon the extent of the disease.

Step 5. Close the wound. Introduce a rubber or cigarette drain through a stab wound (Fig. [illegible]).

Smith Two-Flap Incision for Cancer of the Breast

In order to improve the postoperative results, as far as mobility of the arm is concerned following amputation of the breast for carcinoma, Richard R. Smith[*] devised an incision which permits of the removal of an ample amount of skin and underlying tissue at the same time leaving the arm unhampered by scar thus conducing to freedom of mobility, an important consideration for the patient. This incision is adaptable in almost every case of carcinoma of the breast subjected to radical operation. (See Figs. [illegible], p. [illegible].)

* S. G. O. July [illegible]

Step 1. Make an incision at a point below the middle of the clavicle, extending downward and outward to the edge of the pectoralis major muscle. Continue this incision along the edge of the pectoral muscle to a point near the breast, then continue toward the midline and around the inner side of the breast whence the incision proceeds straight downward parallel with the sternum to a point over the edge of the ribs and the upper part of the rectus muscle. Make an abrupt right angle horizontally and proceed for several inches to a point which permits plenty of mobilization of the lower

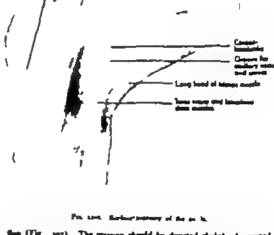


FIG. 1205. Surface anatomy of the axilla.

flap (Fig. [illegible]). The incision should be directed slightly downward, not upward as first described.

Step 2. Make a second incision around the breast beginning at the edge of the pectoralis major and proceeding around the outer side of the breast, then toward the median line to meet the first one.

Step 3. Raise the flaps consisting of skin and all underlying fat; undermine the edges of the incision and remove the breast with all of the fascia, muscle and axillary contents in the usual way (Fig. [illegible]).

Step 4. In closing (Fig. [illegible]) the lower edge near the axilla, made movable by wide removal of the tissues underneath, is [illegible] the angle between the upper flap and upper edge of the first [illegible]

its beginning. The right angle at the lower end of the incision over the rectus is closed and then the two flaps are fitted together and sutured in place. Silk [illegible] may be used where there is any tension, but [illegible] running suture of catgut, or interlocked stitch if preferred, may be used to close those parts of the wound which fall easily together. One should be careful not to create sharp angles, for troublesome sloughing is apt to occur at such points.

Comment. The size and shape of the flaps will vary considerably according to the location of the growth and the elasticity of the tissues. If the edges have been sufficiently undermined and the flaps well mobilized, there will rarely, if ever, be any difficulty in covering the area with the flaps. It is better, however, to leave [illegible] gap or two in the incision to close in by granulation, than to have undue tension. It is well to bear in mind that the line from the shoulder to the middle of the sternum may be snug, but without undue tension, for upon it will depend to [illegible] degree the future freedom of motion of the arm. One must be careful to see that the lower flap, which is ordinarily the much larger one, has [illegible] very wide base or pedicle, as generally speaking, its blood supply is not so good as that of the upper flap.

By making [illegible] smaller upper and correspondingly larger lower flap, or vice versa, one may use this incision for growths situated in almost any part of the breast.

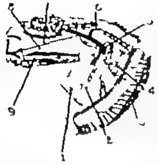


FIG. [illegible] Radical amputation of the breast. [illegible] fascia [illegible] axillary vessels. [illegible] of the axilla [illegible] shown by the dotted line. [illegible] ligament of Gerdy. [illegible] Pectoralis major muscle. [illegible] ligament. [illegible] 4 [illegible] 5 [illegible] 6 [illegible] Axillary vessels showing through fascia. (After Lyle.)

Hemostasis must be perfect. The skin should be closed with interrupted sutures. A stab wound lateral to the axilla is used for drainage (Fig. [illegible]). Complete closure of the wound is not always possible. Plastic operations and Thiersch grafts must frequently be resorted to. Apply voluminous dressings firmly. Allow the arm on the affected side to rest against the chest wall supported by [illegible] triangular sling bandage.

Avoid too long immobilization of the arm. Encourage the patient to move it somewhat after four or five days. Dress the wound and remove the drainage tube after 48 hours.

The axillary fasciae must be completely removed if the operation is to prove successful. These fasciae are three in number, viz. (1) The costocoracoid or suspensory ligament which envelops the subclavius muscle and is fastened by means of [illegible] double root to the clavicle. As [illegible] proceeds downward, it separates into two parts, surrounding the pectoralis minor; then reunites and merges with

the subcutaneous tissue. The ligament of Gerdy emerges from its under surface and passes under the axillary vessels. (2) The deep axillary fascia which covers the muscles also forms the back and outer walls of the axilla; the serratus magnus is covered by [illegible] deep, external fascia; and the largest part of the anterior axillary wall is formed by the deep anterior fascia which is fastened above the clavicle and covers the posterior surface of the pectoralis major. (3) The lower part of the axilla is covered by fascia which reaches from the fascia over the serratus

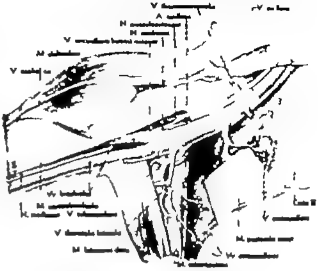


FIG. [illegible] [illegible] of the right axilla, viewed from in front.

magnus to the fascia of the arm. It has an oval-shaped opening, the external border of which is referred to as the arm-arch (Armbogen), and the internal border as the axillary-arch (Achselbogen).

In [illegible] study on the swelling of the arm following radical mastectomy (Fig. [illegible]) J. R. Veal[1] concludes that:

Edema of the arm following radical removal of the breast may be due to lymphatic obstruction, to venous obstruction, or to [illegible] combination of the two factors. The present small series of twenty cases indicates that venous obstruction [illegible] the most common cause.

Obstruction of the axillary vein is due to [illegible] several causes, the chief of which are the presence of the malignant growth itself in its primary or secondary manifestations, scar formation, and the impingement of fat folds.

[1] J. [illegible]

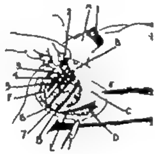
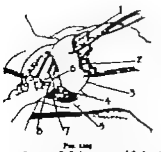


FIG. [illegible] FIG. [illegible]

FIG. [illegible] Radical amputation of the breast. [illegible] (After Lyle.) [illegible]

FIG. [illegible] Radical amputation of the breast. The insertion of the pectoralis major has been divided and the muscle and its fascia reflected over the chest wall. [illegible] (After Lyle.)



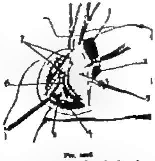


FIG. [illegible] FIG. [illegible]

FIG. [illegible] Radical amputation of the breast. The costocoracoid-axillary fascia has been [illegible] [illegible] (After Lyle.)

FIG. [illegible] Radical amputation of the breast. [illegible] (After Lyle.)

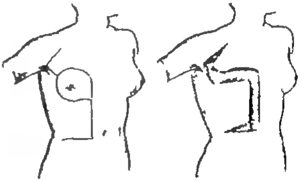


FIG. [illegible] FIG. [illegible]

FIG. [illegible] Incision [illegible] for amputation of the breast. [illegible]

FIG. [illegible] Diagrammatic. [illegible] of the flaps after the breast has been removed.

FIG. [illegible] Chest [illegible] showing [illegible] sutures. (Courtesy Dr [illegible])

3 Constriction may occur only when the arm is dependent and may disappear when the elevation of the arm restores the patency of the vein

A collateral circulation may develop adequate to take care of the venous return

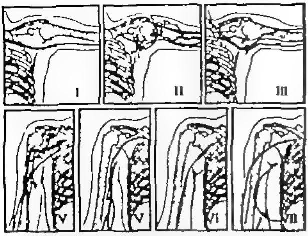


Fig. 1022. Types of axillary vein obstruction … (Courtesy Dr … Veal and the Amer Med Assn, Chicago, Ill)

5 Venography with stabilized thorium dioxide is of value in determining the cause of the edema, but no procedures have yet been devised to remedy … The wisdom of prophylaxis is therefore obvious

THE REMOVAL OF THE BREAST BY ELECTROSURGERY

In this procedure knowledge of the currents used is essential Briefly stated, of late, the high frequency current has been converted into surgical use for cutting purposes Kelly designates this form of surgical division of tissues as acusection Krauss suggests the term of endothermy Other synonyms used for this form of tissue division are electrothermic knife, Bovie knife, endotherm

knife, radioknife etc The use of this method allows of (a) division of tissues, (b) closure of capillaries and small sized blood vessels as well lymph vessels, (c)

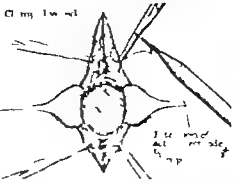


Fig. … Indirect electrocoagulation of small vessel

Fig. 1024. Amputation of the breast for carcinoma. Radical operation by electrosurgical means. All blood vessels treated by coagulation, not single ligature was used. Patient seven days after operation. Primary union.

sterilization of the field of operation, (d) and hemostasis, larger vessels being clamped, the clamp then touched with the endotherm knife and then hemostasis secured (Fig 10) The clamp holding the vessel transmits the current promptly

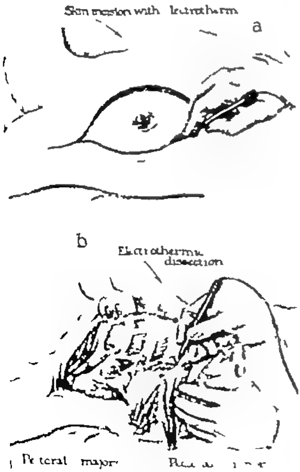


Fig. 1025. Electrosurgical removal of the breast.

to the blood vessel which quickly coagulates. To a great extent this eliminates ligation of larger vessels (Fig)

Electrosurgery lends itself to simple and radical amputation of the breast Howard Kelly and Grant Ward made valuable contributions in popularizing this procedure

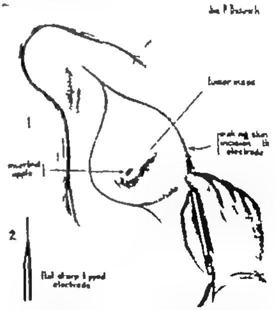


Fig. 1026. Electrosurgical amputation of the breast. Skin incision made with the sharp … electrode … (Kelly and Ward … Electrosurgery, Saunders. Courtesy of Dr Grant Ward)

The entire operation … conducted on the same lines as in the scalpel-scissors technic described in the preceding pages The skin incision (Fig) and the dissection and ablation of the tissues concerned (Fig b) are made with the endotherm knife Instead of ligating the blood vessels they are electrocoagulated

The heat that divides the tissues is not carried by the knife but is produced within the tissues themselves. Do not use pressure Clamp all bleeding points Allow the current to pass through the clamp by applying the endotherm

Be cautious while working near the axillary vessels. The branches springing directly from the axillary vessels are better ligated.

Commenting on the treatment of malignant tumors of the breast by electrosurgical means, Kelly and Ward[1] state: "In developing [illegible] radical

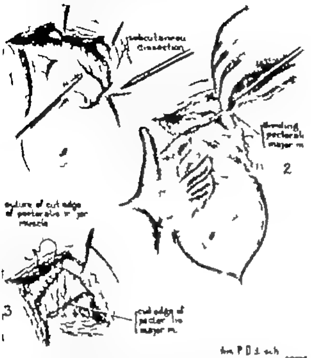
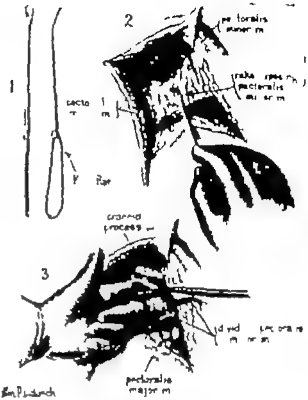


Fig. [illegible]. Electrosurgical amputation of the breast. 1. Subcutaneous dissection with [illegible] current, sealing [illegible] blood vessels, [illegible] and lymphatics. [illegible] (Kelly and Ward: Electrosurgery, Saunders. Courtesy of Dr. Grant Ward.)

operation for the malignant breast, it is not likely that the Halsted-Willy Meyer procedure will be greatly altered. Changes in detail, however, are ever possible [illegible] that [illegible] shorten the operation, lessen the likelihood of infection, and reduce the chance of disseminating

[1] Electrosurgery. W. [illegible] Saunders, [illegible]

tumor cells. Electrosurgery meets these requirements in this field and for this reason there will doubtless be [illegible] growing tendency to resort to it in



[illegible]. Electrosurgical amputation of the breast. [illegible] (Kelly and Ward: Electrosurgery, Saunders. Courtesy of Dr. Grant Ward.)

radical extirpation. Anderson[2] comments that his results have been better than with the scalpel. He emphasizes the sealing of lymphatics and capil-

[2] [illegible]

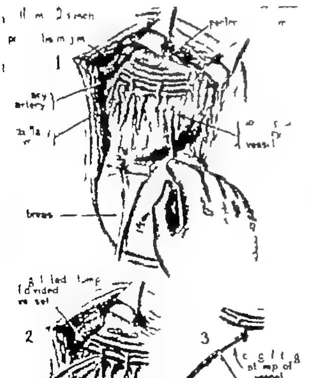


Fig. [illegible]. Electrosurgical amputation of the breast. [illegible] of axillary vessels [illegible] with Kelly [illegible] (Kelly and Ward: Electrosurgery, Saunders. Courtesy of Dr. Grant Ward.)

breast and the lessened complications and loss of body fluids and [illegible] keeping up the body heat by surgical diathermy. Less catgut is left in the wound, as the average number of ligatures used is from six to ten. Healing in his series has been more satisfactory and recurrences less frequent.

"The special [illegible] does not concern us beyond the suggestion that experience will doubtless lead to [illegible] greater readiness to make [illegible] wide ex-

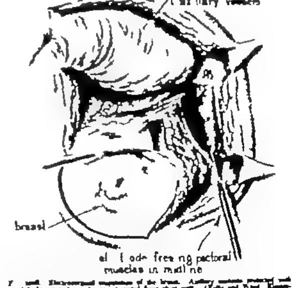


Fig. [illegible]. Electrosurgical amputation of the breast. Axillary contents [illegible] while breast and muscles are dissected from chest wall. (Kelly and Ward: Electrosurgery, Saunders. Courtesy of Dr. Grant Ward.)

cision, sacrificing the hope of effecting an immediate complete closure. The skin incision is made with scalpel or [illegible] (Figs. [illegible]) and the incision carried on through the fat with the [illegible] cutting current. A low voltage and high frequency ([illegible]) tend to prevent [illegible] contractions when the muscles are reached. The axilla is carefully guarded with [illegible] hard rubber or wooden spatula while the pectoral muscles are divided near their insertion.

Although it is practicable to make [illegible] complete dissection of the axilla with the current alone, without knife or scissors, this is not usually prac-

[illegible] because of the risk of injuring the axillary vessels. It is perhaps best for the present to dissect branches of the axillary vessels. A valuable aid in rapidly skeletonizing this region is found in Kelly['s] axillary [illegible]

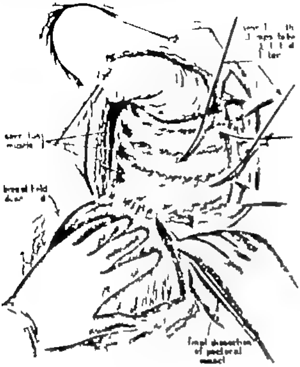


Fig. [illegible]. Electrosurgical amputation of the breast. Axillary contents, breast and underlying muscle removed en masse by cutting current. (Kelly and Ward: Electrosurgery. Saunders. Courtesy of Dr Grant Ward.)

(Fig. [illegible]) [illegible] with greater safety and rapidity than [a] scalpel or with gentle traction it pulls down the investing fat and fascia and quickly skeletonizes the vessels, undercutting them up to their origin at trunk-artery and -vein.

After removal of the breast and axillary glands en masse (Figs. [illegible]) with all bleeding vessels on the thorax caught in well-pointed clamps, complete hemostasis, without ligatures, is secured by hooking up the clamps one by one on the surgeon['s] left hand and holding them at [ri]ght angles to the thorax, and coagulating as described. Or the operator coagulates, while the assistant removes them, saving time.

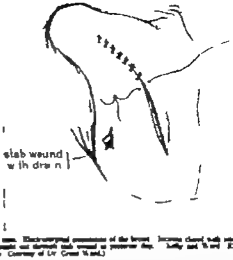


Fig. [illegible]. Electrosurgical amputation of the breast. Incision closed with interrupted silk; drain brought out through stab wound at posterior flap. (Kelly and Ward: Electrosurgery. Saunders. Courtesy of Dr Grant Ward.)

"The measure for duration and amount of current is [a] slight hair-like coagulation ring at the end of the clamp. The time consumed is about one-fifth that of ligating the vessels. In this, more almost than in any other operation, we effect [a] great saving by keeping the foreign ligature material out of the wound. Beverly Chew Smith[1] states that approximately twenty to thirty minutes are saved routinely in mastectomy operations by using clamp coagulation hemostasis rather than ligatures."

SO CALLED "INOPERABLE" TUMORS

Electrosurgery scores striking achievements in so-called [i]noperable tumors (Figs. [illegible]): some become operable, others are relieved and [a] few are cured. One does not see recurrence of the malignant growth in the line of in[cision]

[1] New York Physiotherapy Society, January [illegible]

[illegible] as [in] the case in Fig. [illegible] which depicts skin metastases following amputation with the cold scalpel. Many patients to whom no hope [is] held out can-

Fig. [illegible]. Recurrent carcinoma of left breast with much [illegible] surface. [illegible] lymph node involvement. Electrosurgical removal.

Fig. [illegible]

Fig. [illegible]

Fig. [illegible]. Advanced malignant disease of the breast in [a] young woman. "Too late" was the verdict. [illegible]
Fig. [illegible]. Same patient seen in Fig. [illegible]. Some months after operation.

[illegible] are often benefited following electrocoagulation. I frequently supplement electrosurgical removal of the breast with radiation by deep x-ray or radium. A

combination of these procedures has served me well. Such patients find themselves relieved of pain and malodorous discharges. A feeling of *bien être* is often noticed.

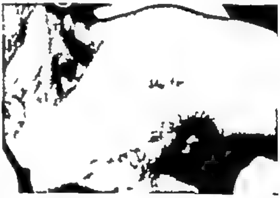


Fig. [illegible]. [illegible] metastases following amputation of breast with scalpel.

Many years of comfort often follow the removal of large tumors. After the coagulation separates, healthy granulating base often develops which is receptive for skin grafting. Before grafting, however, fragments of such granulations should be examined microscopically to discover the presence or absence of malignancy. The periosteum, when involved, should also be submitted to destruction by electrocoagulation.

CHAPTER 26

SURGERY OF THE BRONCHI

BRONCHOSCOPY

This is usually done under local anesthesia using the technic that has been described for direct laryngoscopy (see p. 383).

The Chevalier Jackson laryngoscope is then introduced and held in the left hand. An assistant places the bronchoscope into the right hand of the operator who then introduces it through the laryngoscope. The surgeon now shifts his [illegible] to the bronchoscope, and with the slanted portion of the instrument against the left vocal cord, passes it through the glottis. It should go through easily and very little pressure should be used. The air passages are then carefully examined, following the lumen of the tracheobronchial tree. Jackson states that only by thorough knowledge of the anatomy of the tracheobronchial tree and the experience of frequent bronchoscopy on [illegible] cadaver will the operator always know where his tube-mouth is in the tracheobronchial tree.

FOREIGN BODIES IN THE TRACHEA

By inverting the patient, [illegible] foreign body may be expelled, provided that the foreign substance is not impacted. Lopez condemns this method.

Tracheoscopy or tracheobronchoscopy (Killian) (see chapter on Surgery of the Neck) per os or via the trachea often proves successful. Technical dexterity is essential to cope with these cases (Fig. [illegible]).

Removal of Foreign Bodies from [illegible] Bronchus by the Tracheal Route

Step 1. General anesthesia.
Step [illegible]. After the trachea has been opened, place the patient in the dependent position.
Step 3. Retract the edges of the tracheal wound with retractors or sutures. Lift the foreign body with appropriate forceps (Fig. [illegible]). Coughing and inversion of the patient may bring [illegible] non-impacted body from the bronchus into the [illegible] wound.
Step 4. Insert [illegible] tracheotomy tube for several days.

If the above means fail to give relief, [illegible] suggests either suturing the edges of the tracheal wound to the skin or inserting [illegible] large cannula and allowing the patient to rest. After some hours, or next day, the wound is re-opened; if the object is not now coughed out, [illegible] small laryngeal mirror is introduced and the trachea is investigated by the aid of [illegible] strong light. If the foreign body is caught in the mucous membrane, cocaine should be sprayed in and laryngeal forceps or [illegible] used for its extraction. Several sittings may be necessary before the object is removed.

Impacted Foreign Body in [illegible] Bronchus

Posterior bronchotomy may be resorted to or the formation of [illegible] pulmonary abscess awaited, when this may be opened and drained. The former is [illegible] [illegible]

[illegible] operation and the latter rather impractical (patients may die before or after [illegible] of the lung).

Posterior Bronchotomy (Schwartz [illegible] Operation)

The bronchi may be reached through the posterior mediastinum (see [illegible]'s technic of posterior mediastinotomy in this chapter).

Right Bronchotomy

Place the patient in the right latero-ventral position on the edge of the table with the right arm hanging over the table (Fig. [illegible]).

Step 1. Make an incision from the point at the junction of the spine and median border of the scapula to [illegible] point about [illegible] inches to the right of the

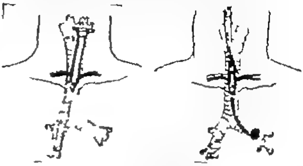


Fig. [illegible]. Bronchotomy. Direct endoscopy of the right bronchus through [illegible] incision. (After Dupuy.)
Fig. [illegible]. Removal of [illegible] foreign body [illegible] lodged in the left bronchus with [illegible] curved forceps introduced through [illegible] tracheotomy [illegible]. (After Dupuy.)

spines of the thoracic vertebrae. Extend the incision downwards, parallel to the spinous processes of the vertebrae for [illegible] distance of about five inches and complete [illegible] [illegible] [illegible] just below the angle of the scapula, that when the flap is reflected it will expose the fifth, sixth, seventh and eighth ribs. (J. D. Bryant fashions [illegible] flap with its pedicle towards the spine.)
Step [illegible]. Divide the spinal ends of the exposed ribs subperiosteally, just external to the transverse processes. Divide the ribs as far outward as possible. Separate the flap, consisting of ribs and intercostal muscles, from the subjacent structures. Divide the intercostal muscles along the prolonged line [illegible] which the ribs were divided. Ligate the intercostal vessels. Divide the intercostal muscles parallel to and below the lowest rib to be mobilized. Similarly cut through the intercostal muscles parallel to and above the highest rib to be mobilized. By blunt dissection, separate the parietal pleura from the flap of ribs and intercostal muscles. Reflect the flap outwards (Fig. [illegible]).

Step 3. Cautiously separate the pleura from the remnants of the ribs attached to the spine and from the side of the vertebrae. Displace the pleura and the lung outwards, away from the mediastinum (Fig. [illegible]). The azygos vein will be seen running vertically at the upper end of the wound arching for-

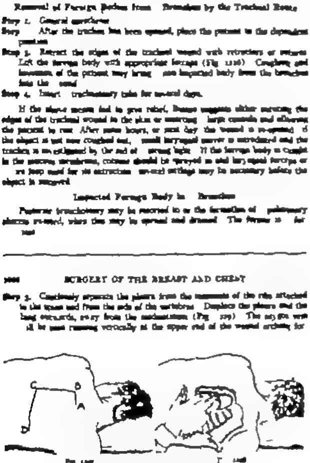


Fig. [illegible] [illegible]
Fig. [illegible]. Bronchotomy. Schwartz's operation showing lines of incision for [illegible] of the osteoplastic flap.
Fig. [illegible]. Schwartz's operation showing displacement with the hand.

wards to reach the anterior mediastinum (Fig. [illegible]). Further separate the pleura under the arch of the azygos vein until the esophagus [illegible] exposed. The pneumogastric nerve [illegible] be observed on the esophagus. Retract the pleura outwards.

Fig. [illegible] Fig. [illegible]
Fig. [illegible]. Schwartz's method of exposing the right bronchus.
[illegible]. Schwartz's method of exposing the left bronchus.

Step 4. Search for the posterior border of the cartilaginous rings of the bronchus in the concavity of the arch of the azygos vein. With the aid of [illegible] sharp hook, pick up the posterior wall of the bronchus and incise it. Remove the foreign body.

5. Introduce [illegible] soft drain to the wounded bronchus. Hard drains may

cause dangerous pressure necrosis. Replace and suture the flap into place. The drain leaves the wound at [illegible] lower angle.

Left Bronchotomy

The patient is placed in the left latero-ventral position with the left arm hanging over the edge of the table.

Steps [illegible] and 2. Are the same as in performing right bronchotomy except that the operation is performed on the left side.

Step 3. Separate the parietal pleura from the remnants of ribs attached to the spine. On the side of the vertebrae, the aorta is encountered. The arch of the aorta passes towards the upper end of the wound. Separate the pleura under the arch of the aorta to [illegible] height of about [illegible] inches. The left pneumogastric nerve will be encountered. Displace the lung, which is covered by the intact pleura, outward [illegible] an appropriate retractor. Feel for the posterior prominent edges of the bronchial cartilages. The rest of the operation is the same as in right bronchotomy (Fig. [illegible]).

CHAPTER 27

SURGERY OF THE THORAX, PLEURAE AND LUNGS

Historical Notes. The history of surgery of the lungs is [illegible]. Hippocrates recommended opening of the pleura in cases of empyema. A lull is now noted until [illegible] when Schmidt suggested surgery in the treatment of abscess of the lung. Roche and Bertrand in [illegible] followed suit. Delbary ([illegible]), Faye ([illegible]), Jacques ([illegible]) and Sharp in [illegible] suggested opening of lung abscesses by incision. [illegible] Hoff and Kruse in [illegible] and Fisher in [illegible] entered the chest with [illegible] trocar. The names of Ring ([illegible]), Jovanka ([illegible]), Krause and Koch ([illegible]) are prominently connected with this phase of surgery. Later and Quincke, Agostolo Gluck, Sauerbruch, Lilienthal, Graham, Jacobaeus, Nissen, Churchill, Reinhoff Jr. and others made notable contributions.

Anatomic Considerations. The Pleurae. The parietal pleura is divided into the costal, diaphragmatic, mediastinal and cervical portions. The cervical part [illegible] braced by Sibson's fascia that extends from the transverse processes of the lower cervical vertebrae to the apex of the pleural sac. The costal pleura is [illegible] substantial structure and [illegible] separated from the parietes by the endothoracic fascia. The diaphragmatic pleura [illegible] very thin and firmly connected with the underlying muscle. The visceral pleura surrounds every part of the lung except at [illegible] hilus its fissures and is adherent to the pulmonary parenchyma. The ligamentum latum pulmonis is [illegible] triangular fold of pleura which passes from the inner surface of the lung to the pericardium.

GENERAL CONSIDERATIONS

Methods of Maintaining Respiration When the Thorax Is Opened

Meltzer and Auer's Method. This is [illegible] method of artificial respiration brought about by intratracheal insufflation of air. A small tube is passed through the larynx into the trachea almost to its bifurcation. By means of [illegible] foot bellows or electric motor air mixed with ether is blown continuously through the tube under pressure of about [illegible] to [illegible] mm. of mercury. The lungs are kept moderately distended, the blood [illegible] thus aerated and the excess air escapes alongside the tube.

Numerous apparatus are on the market to accomplish the desired results.

Sauerbruch was first to construct [illegible] cabinet by means of which the thorax could be freely opened and respiration kept up either under negative or positive pressure.

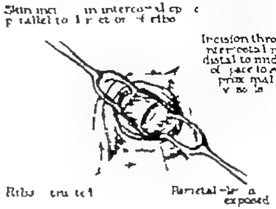
Negative Pressure Cabinet. In the use of this cabinet, the patient's body, the surgeon and assistants are on the inside of the cabinet. The head of the patient projects through an aperture at one end of the cabinet, his neck being surrounded by an air tight collar. By means of an air pump, controlled by [illegible] manometer, the air pressure on the inside of the cabinet [illegible] sufficiently lowered to permit respiration to continue after the thorax is opened.

Positive Pressure Apparatus. The cabinet [illegible] the same as negative pressure cabinets with the difference that the patient's body [illegible] on the outside [illegible] his head and the anesthetist are on the inside of the cabinet. The pressure of the air on the inside of the cabinet is increased by means of an air pump.

BASIC OPERATIONS ON THE THORAX

The thoracic cavity is opened because of (a) empyema and for (b) exploration of the thoracic contents and ( ) exploration of the mediastinum.

An empyema may be evacuated by thoracentesis (simple puncture and aspiration) or by thoracotomy (simple intercostal incision). For these procedures local or general anesthesia may be used. The former is all that is required in the majority of instances.



[illegible] Thoracotomy

THORACOTOMY

Step 1. An incision is made about two inches in length and running parallel with the ribs. It should begin just anterior to the latissimus dorsi muscle and correspond to the sixth, seventh or eighth intercostal spaces (Fig. [illegible]). Divide the intercostal muscles distal to the middle of the intercostal space, thus avoiding the intercostal vessels and nerves.

Step [illegible]. Careful hemostasis. Make [illegible] small opening in the parietal pleura. Avoid too rapid evacuation of pus. Enlarge this opening with [illegible] pair of hemostats or the finger. Remove blood clots, shreds and fibrin. Leaving these behind causes delay in healing and they may obstruct the opening created for drainage.

Step 3. Insert [illegible] rigid rubber tube into the pleural cavity. Not much of the tube should project into the cavity and it should be kept from slipping by stitching or by attaching it to the skin with [illegible] safety pin. Apply [illegible] voluminous

minous dressing. Irrigation with saline or Dakin solution may be necessary in some cases.

Comment. The first case of thoracotomy under intratracheal insufflation anesthesia in the human being was done by Howard Lilienthal in [illegible].

THORACENTESIS

Object. Removal of fluid from the chest cavity. The procedure may be (a) exploratory or (b) therapeutic. In all operations here, the strictest asepsis must be maintained.

Instruments. Exploring trocar, aspirating or Dieulafoy trocars. Potain aspirator (Fig. [illegible]).

Without Admission of Air

This [illegible] much preferred in children and infants. Select the posterior axillary or scapular line. Antisepticize the skin thoroughly. Enter the trocar in the 5th, 6th or 7th intercostal space. Have the patient sit up [illegible] whenever possible. Introduce the trocar at the upper border of the respective rib in order to avoid injuring the intercostal vessels. Permit the fluid to escape slowly; stop aspirating [illegible] about three-fourths of the fluid accumulation has been drawn off. Should the patient complain of dyspnea, faintness, severe cough or dizziness, interrupt the procedure. If the condition recurs, do not inject half as much oil as fluid removed. When through put some collodion over the puncture made by the trocar.

With Admission of Air

This procedure offers [illegible] number of advantages over the preceding. The admission of air avoids negative pressure, which is responsible for such untoward symptoms as severe cough, dyspnea, pain and weakness which are often observed when the first method is practiced.

Procedure. Introduce the trocar at the most dependent part of the intrapleural accumulation, permitting some air to enter. When the latter has been removed, the opening created by the trocar is closed with collodion or [illegible] small square of iodoform adhesive plaster.

Comment. Avoid careless introduction of the trocar lest injury to the lung tissue, heart or intercostal vessels ensues. Avoid passing through the diaphragm thus invading the peritoneal cavity. Stay above the ninth rib posteriorly and the sixth rib anteriorly.

Rib Resection (Costectomy)

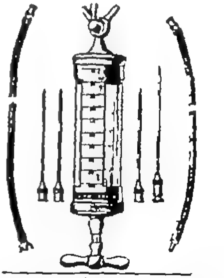
Practical Considerations. The removal of [illegible] portion of [illegible] rib is most commonly performed for the purpose of draining an empyema. Usually [illegible] portion of the ninth or seventh rib is removed in the midaxillary line. It is to be remembered that the second to the seventh ribs are covered posteriorly by the scapula. The ribs lying below the eighth are so closely related to the diaphragm that the latter may be injured during costectomy.

[illegible] of bypass [illegible]

The removal of [illegible] segment of one or more ribs does no permanent harm.

Position of Patient. It [illegible] best to place the patient with the sound side uppermost, midway between the lateral and ventral position [illegible] the patient lying half over the abdomen. The sound side must never be undermost, otherwise respiration will be interfered with. The illustration (Fig. [illegible]) shows how [illegible] should not be done.

Anesthesia. Local infiltration anesthesia with novocaine one half of one



[illegible] Dieulafoy aspirator

per cent. solution in most instances (Fig. [illegible]). Infiltrate the solution along the course of the proposed incision. The area to be blocked by the anesthetic should embrace about one intercostal space above and one below the line of infiltration.

Step [illegible]. The incision should be two or three inches in length, along the long axis of the rib chosen for resection and halfway between its upper and lower borders. Divide the periosteum along the line of the incision with [illegible] curved periosteal elevator (Fig. [illegible]).

Step 2. The intercostal vessels are separated from the bone [illegible] is the periosteum by means of [illegible] Doyen instrument (Fig. [illegible]). Avoid accidental opening of the pleura at this stage of the operation. Resect the parts through

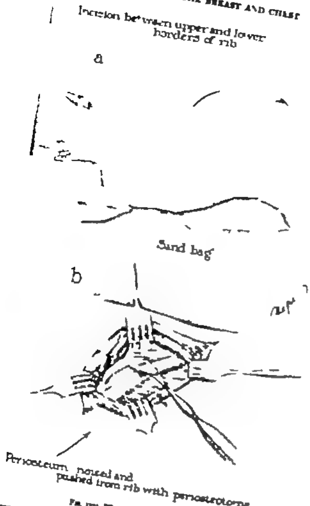


Fig. 1135 Rib resection (continued)

Divide the exposed portion of the rib with properly constructed rib shears (Fig 1136) Remove about two inches of the ribs Aspirate (Fig 1137)

Step 3 Make small incision along the aspirating needle dividing the periosteum and parietal layer of the pleura (Fig 1137 b) Allow pus to leave slowly too rapid evacuation may cause pulmonary congestion and if not guarded against, fatal emonia of the brain

Fig. 1136. Black arrows ... rib resection where one rib is to be resected the ... area ... collateral ... and subcutaneously and after the ... ... are ... ... collected.

WOUNDS OF THE LUNGS AND PLEURAE

These usually result from ( ) stabs (b) bullet wounds, (c) trauma, the result of fragments of fractured ribs and (d) surgical operations.

Dangers

( ) Pneumothorax, ( ) Pyothorax, (3) Haemothorax, (4) Pulmonary Collapse, (5) Shock, (6) Air Embolism

TREATMENT OF PENETRATING WOUNDS OF THE CHEST

Determine the patient's vital capacity This indicates the extent of surgery permissible in given case

Encourage the patient to lie on the affected side

Exert steady pressure on the injured side of the chest (compression bandage)

3 Enlarge the wound explore remove foreign bodies cleanse, debride attend to haemostasis See if the pleura is injured If so, repair Explore for injury to the lungs If wounded, suture the wound in the lung

4 Pack loosely and partially close the external wound

5 Dress Apply dressing to immobilize the chest (adhesive tape)

6 If haemorrhage cannot be arrested by the measures suggested augment the existing pneumothorax

7 Nonintervention has many advocates (Clement et al)

SUTURE OF THE LUNGS

Step Enlarge the original incision inflicted by the trauma, along an intercostal space or combine with rib resection as indicated Exposure must be ample at any cost

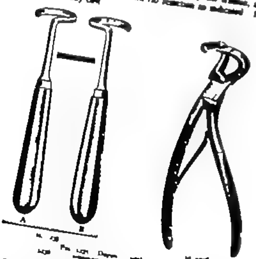


Fig. 1138 Fig. 1139 Doyen ... rib raspatory ... Fig. 1140 ... raspatory and laminectomy shears Doyen

Step 2 Using the hand or special forceps pull the lung into the wound just sufficiently for exposure, not too much, but respiratory embarrassment ensue (reflex action) (Fig 1141)

Step 3 Isolate the wound Clamp temporarily with proper elastic forceps that will not compress the lung excessively Ablate ragged edges where present Ligate larger vessels and bronchi with fine silk If the injured parts are extensive, resect them Alternatives suturing of the injured lung into the cutaneous wound tamponade and drainage

Step 4 Suture Use fine curved needles with silk Catgut is not as pliable as silk or linen Ligate carefully Approximate, do not strangulate Tinged mercurials touching the suture apertures with some perchloride (Figs. 39-1140)

Lung tissue is more resistant than is commonly supposed Tension sutures are occasionally of value

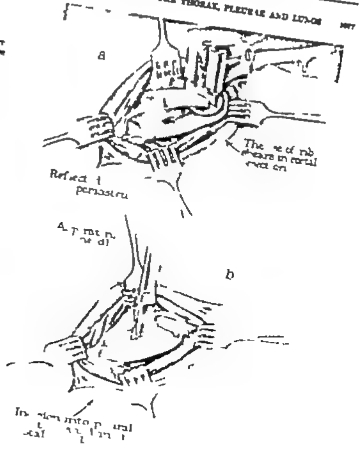
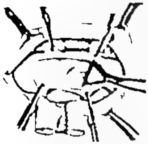


Fig. 1137 Rib resection. Continued

Step 5. The pleura may or may not be sutured, proceed as indicated. If sutured, Lembert type inversion sutures are to be used (Fig. [illegible]).
Step 6. Close the wound. Usually done.



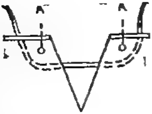


Fig. 1238 [illegible] Fig. 1239
Fig. 1238. [illegible] end of [illegible] been opened pleura. [illegible] grasped and steadied and ready to placing of [illegible] sutures.
Fig. 1239. [illegible] method of suturing of the lung [illegible].

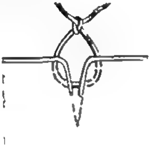


Fig. 1240 Fig. 1241
Fig. 1240. [illegible] method of suture of the lung. A, Longitudinal suture acts as an efficient support for the [illegible] placed sutures. Fig. 1241. [illegible] suture of the lung.

Hernia of the Lung

Pneumatocele (hernia) is the result of some congenital or acquired locus minoris resistentiae.

Treatment. Compression (pads).

Operation. Plastic closure of the hernial opening.

Trauma resulting in hernia of the lung is treated by reduction of the prolapsed lung. If not incarcerated, this is followed by external compression. If the lung segment is infected ligation of its base and removal of the necrotic portion

with the electro- or thermocautery is resorted to, followed by repair of the cutaneous opening, if the wound is clean; if not, drain.

PNEUMOTHORAX

Pneumothorax, the result of fractured ribs, is characterized by (a) cyanosis and (b) embarrassed respiratory and heart action.

Treatment. Aspiration is usually followed by prompt relief. If the wound in the lung is closed, relief is permanent; if open, distressing symptoms will continue and operative intervention becomes imperative.

Operation. (a) [illegible] costectomy (p. [illegible]) to gain access to the wound in the lung. (b) Treat the injury to the lung as described. (c) Compress.

EMPHYSEMA

This condition often follows fractured ribs or stab wounds but may also occur subcutaneously if air reaches the cellular spaces through the tubes during the process of injecting saline solution. The severity of the case depends upon the quantity of air introduced and the nature of the injury.

If [illegible] fractured rib is responsible for the emphysema, strapping, morphin, ice bags and absolute rest is the treatment.

Fig. 1242. [illegible] fracture [illegible] the ribs with resulting pneumothorax.

If [illegible] penetrating wound caused the emphysema, cleanse the wound and give antitetanic serum at once. Thoroughly immobilize the chest, keep the patient at absolute rest (mental and physical) and treat symptoms as they arise.

If [illegible] large area is involved and [illegible] seems to be spreading, the subcutaneous tissues should be incised and the air permitted to escape.

A cadet about 20 years of age was injured during [illegible] scholastic fencing meet. His opponent [illegible] foil broke and the broken end entered the right chest at the midaxillary line of the second interspace. The lung was penetrated and immediate hemoptysis resulted. The usual picture of [illegible] partial pneumothorax developed [illegible] with associated dyspnea, cyanosis, cough and blood-streaked sputum (Figs. 1243, 1244). A few hours following the injury [illegible] rather diffuse and rapidly spreading surgical emphysema developed [illegible] which extended from the right costal region and upper right sector then up to the right supra- and infraclavicular fossae, this extending medially to about the midline. A definite sense of crepitation could be elicited upon palpation. However the amount of air in the right infraclavicular fossa was so marked that [illegible] definite protruding and [illegible] mass resulted. Adhesive strapping was applied from clavicle downward to prevent the further ascent of the air into the neck thereby avoiding further respiratory embarrassment. Under [illegible] symptomatic regime associated with absolute bed rest the lung re-expanded, the hemopneumothorax disappeared and the subcutaneous effusion was entirely absorbed.

Another case which came under my attention was that of an old nurse (69

years of age). [illegible] in extremis (Fig. 124[illegible]). She sustained fractured ribs, [illegible] fragment of [illegible] which penetrated the lung. Emphysema developed which rapidly extended into the neck and subcutaneous tissues. Embarrassed heart action and the rapidly spreading emphysema caused death.

Fig. 1243 Fig. 1244
Fig. 1243. Traumatic pneumothorax and surgical emphysema. Partial collapse of the lung with hemothorax the result of stab wounds. [illegible] [illegible] subcutaneous tissues [illegible] spread over the right supraclavicular area [illegible] partially collapsed lung [illegible] right [illegible] and [illegible] partially obliterated.
Fig. 1244. Surgical emphysema. Same patient [illegible] complete expansion of the lung and apparent [illegible] of emphysema.

Mediastinal Emphysema

An injured trachea, bronchus or esophagus which permits the constant escape of air into the mediastinum [illegible] the usual cause of mediastinal emphysema. This condition [illegible] life threatening and demands that immediate steps be taken for relief.

An incision [illegible] made on the anterior aspect of the infrathyroid region of the trachea down to the trachea. Secure hemostasis as the operation progresses. A suction apparatus is then improvised which will gradually withdraw the escaped air from the mediastinum. Continuous suction may at times be resorted to depending upon circumstances. Where the air leaks from [illegible] wound in the trachea, the latter [illegible] will have to be repaired by suturing the opening.

RÉSUMÉ OF TREATMENT OF INJURIES OF THE LUNG

Ambrose L. Lockwood[illegible] recommendations for operation in injuries of the lung are summarized as follows:

"1. Operate on all patients with an open pneumothorax (traumatopnea).

[illegible] Surg. Gynec. and Obst., Feb. [illegible]

"2. Operate on all patients with laceration of the diaphragm as well.

"3. Operate on all patients with [illegible] badly 'stove-in' chest, with overriding fragments and sharp spicules where the pleura is lacerated, even though there is no external wound.

"4. Operate on all patients where [illegible] jagged irregular missile has entered the pleural cavity, whether lodged in (a) the chest wall, (b) the pleural cavity, (c) the lung, (d) the mediastinum, or (e) the heart or pericardium.

"5. Operate on all very severely infected patients, even though the missile is not retained.

"6. Operate on all patients with [illegible] penetrating wound of the chest with progressive bleeding, hemoptysis and massive hemothorax.

"7. Operate on all patients with [illegible] massive pneumothorax and great displacement of the heart and mediastinum that cannot be controlled by aspiration.

"8. Operate on all patients in whom rupture of [illegible] main bronchus or artery at the hilum of the lung is suspected.

"Thoracotomy is rarely indicated for relief of the ordinary hemothorax or hematoma of the lung. Unfortunately occasionally lung abscess or more rarely gangrene of the lung results from an extensive hematoma of the lung, but unless thoracotomy is necessary otherwise, we believe such patients should be treated expectantly.

"The modern gas oxygen machine with [illegible] snugly fitting mask applied to the well anesthetized face affords all the positive pressure necessary for re-oxygenation and offsets the danger of [illegible] prolonged open pneumothorax. Intratracheal gas oxygen anesthesia in the hands of an experienced anesthetist should be employed for [illegible] prolonged thoracotomy.

"Paravertebral anesthesia for two or three spaces above and below the wound or the site of the lesion, with local infiltration, to avoid delay associated with gas oxygen analgesia, is the anesthesia of choice. Emergency cases that would never be fit for [illegible] general anesthetic can be safely operated upon with this type of anesthesia. A more extensive, deliberate, and protracted operation can be undertaken with the minimum of shock to the patient. Respirations are deeper and more regular than with [illegible] general anesthesia, and the movements of the lung, mediastinum, and diaphragm can be voluntarily controlled by the patient to an appreciable extent. The two stage operation, in which both sides of the thorax are opened, is possible only with this type of anesthesia. Postoperative restlessness, vomiting, retching, coughing and straining are avoided, and this plays no small part in the success of such operations, especially in bad risk patients.

"Operation. The complete intrathoracic operation must not be lightly undertaken. The preparations for operation, the anesthetic, and the technique of the operation are most exacting, although the manipulations themselves within the thorax do not require any exceptional dexterity. Speed is essential. Absolute asepsis must be maintained.

"For operation the patient should be placed with the injured side

dependent, usually in the half-sitting posture. Primary union will not result without bold, thorough excision of the wound area.

"When the position of the wound will permit, resection of the fourth rib or preferably a long incision in the interspace immediately below it from the midclavicular to the posterior axillary line furnishes current access to the thoracic cavity. A powerful, snugly fitting rib retractor is necessary.

"The commonest source of bleeding is from a torn intercostal artery. If the artery cannot readily be picked up and ligated with a small pursestring needle, a suture can be passed around it or, failing that, around the rib itself.

"The lung can be freely handled, sutured, or a wound excised as required. If the wound is of a [illegible] type in the lung, tags of intercostal fascia and muscle should be laid over the edges and sutures passed through them; this will relieve tension on friable lung tissue when the edges are approximated. Bronchial fistulae will invariably be avoided if the visceral surfaces are carefully apposed.

"Partial, or even complete lobectomy may be necessary, depending on the degree of laceration of the lung. In such a case preserve plenty of the visceral pleura.

"An open bronchus or alarming hemorrhage from the lung surface is rarely found at operation.

"The tailor of the pleura must be meticulous.

"The thoracotomy incision should be closed with a thick, moist towel, every moment that the hands of the operator are not within the thorax.

"Time should not be wasted in attempting to repair the parietal pleura.

"The chest must be hermetically closed with the first layer of muscles; otherwise, pocketing will occur, pleural effusion accumulate, the incision break down, and an empyema result.

"Careful approximation of the skin edges is necessary to insure early absolute primary union.

"Drainage of the chest should never be employed in these primary operations.

"Great injuries of the bony wall of the chest associated with injury to the lung require that all comminuted bone and sharp spicules be widely excised. If the intercostal nerves have been torn, employ alcohol injection prophylactically to offset pain during convalescence.

"Postoperative treatment. The postoperative treatment of chest wounds demands constant attention. The patient should be maintained in the position found to be most comfortable. Oxygen should be employed if the patient is cyanosed. Morphine should be freely used to combat restlessness.

"Aspiration should be carried out 48 hours after operation and as frequently as necessary to keep the pleural cavity relatively free of fluid. Early fluoroscopic examination or roentgenograms will help to determine the presence of a collection.

INFECTIONS OF THE LUNGS EXCLUSIVE OF TUBERCULOSIS

LUNG ABSCESS

Lilienthal[a] points out that the principles of the operations for lung abscess are always the same, namely:

The head of the patient should be lower than his hips.

Local anesthesia should be used if possible; if not, some extremely light form of so-called analgesia should be used so that the cough reflex may not be abolished and the danger of aspiration into the opposite lung may be reduced. Heavy narcotic dosage and anesthesia by avertin or other drugs should be avoided.

3. Evacuation should be by the most direct route avoiding free pleural involvement.

4. The drainage opening should be well above the lower limit of the abscess.

5. Manipulation of the cavity should be gentle so as to prevent dangerous hemorrhage.

6. One should refrain from the natural surgical tendency to completely unite multiple abscess cavities at the time of operation.

7. The packings should never be so firm as to dislocate the mediastinum.

8. Wherever adhesions are found rubber dam should be employed as packing.

9. The wound pattern makes comparatively little difference but an opening high enough to enter the abscess by the most direct route should be employed with such preliminary or additional incisions as may be necessary for perfect exposure. As a rule, chest wall flaps should not be employed, even though they apparently permit of drainage at the lowest point, because frequent dressings will be necessary and the flap impedes complete exposure.

Comment. In lung abscess one may wait from six to eight weeks during which conservative treatment should be resorted to. A large majority of these cases heal spontaneously during this time. Particularly is this true in abscess which has perforated into a bronchus (abscess in the upper lobe and region of the hilus). The procedure of choice after an unsuccessful period of waiting with conservative management is pneumonotomy. Pneumectomy should only be resorted to in the presence of abscess of the lower lobes. [illegible] emphatically warns against the use of therapeutic pneumothorax in these cases and admonishes that aspiration of the abscessed cavity is even more dangerous. Bronchoscopic suction of pus is also deprecated as being of little value, if any. Where the condition of the patient is bad, the less interference, the better. The keynote to success is to put the affected lobe at rest wherever possible; even though one takes into the bargain a possible infection of the pleura artificial pneumothorax is advocated.

PNEUMONOTOMY

Pneumonotomy indicates the creation of an opening into the lung usually for abscess. The operation may be beset with difficulties. In cases of superficial abscess the suppurative focus is opened with either scalpel or thermo- or

electrocautery; its contents are evacuated and the resulting cavity drained. Hemorrhage is usually in proportion to the depth of the suppurating focus and proximity to the hilus of the lung. Exposure must be ample. If one of the larger vessels bleeds, ligation is called for. Often, with more careful search, a small abscess of the lung may be overlooked. An exposed lung may be explored with a blunt aspirating needle or by palpation. Tuffier, after rib resection, separates the parietal pleura from the inner surface of the chest wall and palpates the lung akin to extraperitoneal palpation of the abdominal viscera. Once the abscess cavity is widely opened, it should be thoroughly explored and drained. Do not curet; it may be followed by marked hemorrhage. Drainage is best accomplished by tamponade and rubber tube drain. Do not irrigate.

The treatment of acute abscess and gangrene of the lung is surgical. The foci are usually solitary in acute conditions; multiple in chronic. Procrastination may be permitted in the latter; prompt action in the former unless the arsenicals given intravenously are followed by prompt amelioration.

Avoid exploratory punctures unless you are prepared to operate at once. At any event resort to puncture only after the pleura has been exposed (cocainize). Operate under local anesthesia. In active hemorrhage or progressive processes the majority of surgeons incline to prompt interference (tamponade, exposure and ligation of the bleeding vessel).

In localized abscesses do:

Step 1. Costectomy.

Step 2. Expose the involved area.

Step 3. In the absence of adhesions, outline the abscesses by circular sutures in the same manner as described under transpleural approach to abscess of the liver (which see).

Step 4. Open and drain.

Thoracotomy with Tamponade

CORNER'S METHOD

The most important contributions to the subject of pulmonary abscess, before Corner described his treatment by tamponade, are those of Mikulicz and Perthes. Mikulicz advocated surgical intervention (thoracotomy) while Forlanini recommended artificial pneumothorax; this latter did not find much favor. The only technic adopted since was rubber tube drainage.

Corner, in 1916, described his method of tight tamponade. This he discovered by accident in using a tight tamponade to obtain hemostasis. When the pack was removed after three days the floor of the pulmonary abscess was found dry and in the process of granulation. Clairmont lauds the method as perfectly meeting all requirements because pulmonary abscess is not amenable to any other than surgical intervention (rapid and complete drainage). The after-care is reduced in Corner's procedure to simple and short medications, not requiring tubes which may cause pleural irritation or costal osteomyelitis. Corner uses the procedure as a method of choice, if possible, in one step, and not before the [illegible] week of the disease and never later. He cites the following reasons: First, to afford an opportunity for spontaneous healing, that occurs in 20 per cent of cases; second, to permit formation of sufficient pleural adhesions; and, third,

not to operate later than six weeks, because the patient's resistance might break down, and complications inherent to the lung suppuration process develop.

Aspiration seems to be the most frequent determining cause; however, not all are exclusively due to aspiration of infectious material, but also to absorption via the lymph and blood vessels. Diseased and infected tonsillar or dental bed may be etiologic factors. Chronic abscesses are usually large, and the surrounding fibrosis varies in degree and extension.

Anesthesia. Ether or avertin anesthesia. Administer physiologic salt solution by hypodermoclysis, beginning before and continuing throughout the operation. The position of the patient should be one which is most convenient for the opening of the abscess cavity.

Step 1. Make an incision 8 to 10 cm. in length along the rib crossing the center of the abscess. Resect about 5 cm. of rib subperiosteally. If the subpleural tissues are found unaltered and devoid of respiratory movements (palpation and inspection), incise the abscess cautiously with a very sharp knife or the electrothermic (?) knife first.

Step 2. If the diagnosis is found to be correct, introduce iodoform gauze pending a second intervention about one week later. If the localization is exact, introduce the needle of an aspirating syringe into the abscess cavity allowing the pus to discharge, then introduce a grooved director.

Step 3. If the abscess cavity extends upward, resect a portion of the rib above. If it extends downward, remove part of the rib below. At all events obtain adequate drainage in every case.

Step 4. Suture the intercostal muscles with the intercostal vessels to the side of the wound. Remove the ribs where indicated. Break down adhesions between the multiple abscesses; convert them into one cavity. Dry the cavity with gauze sponges; tampon rather tightly with iodoform gauze. Leave the cutaneous wound wide open. Cover its margins with gauze impregnated with vaseline. Place a dry dressing over the entire area.

Comment. If the uninfected pleural cavity is opened inadvertently during the operation, tampon the abscess cavity as usual with iodoform gauze, and the opened pleural cavity with simple gauze.

Give blood transfusions in case of collapse. Place the patient in semi-sitting position after the operation; as soon as his condition permits, allow him to get out of bed. Remove the tampon between the third and fifth days, usually on the fourth. As a rule, the cavity will be found clean (the bronchial aperture visible). Tampon the cavity a second time, and from then on, every second day, but each time less tightly than the previous time, permitting the cavity to granulate from the bottom up. As soon as granulation is far enough advanced, the wound is allowed to heal up to about [illegible] cm. width. This opening is left patent for at least four months, or until recovery has ensued (by physical condition of patient).

EMPYEMA

Drainage of the Thoracic Space

"The principle of treating acute empyema as an acute abscess by prompt evacuation should be abandoned" (Graham).

According to Lilienthal, drainage of the thoracic spaces may be undertaken according to the four distinct forms of the disorder: (1) peripheral empyema; (2) mesial empyema (often miscalled mediastinal); and (3) the collection of pus between the diaphragm and the lung which Lilienthal has called supraphrenic empyema. The latter has a tendency to extend laterally and upward. It is sometimes necessary to differentiate between supraphrenic empyema and subphrenic abscess. This can easily be done when the disease is on the right—the more usual side—by introducing a little oxygen into the peritoneal cavity through a needle and then making an x-ray film with the patient upright. On the left side a drink of carbonated water will produce a gastric bubble which will function in an x-ray film in the same manner as a pneumoperitoneum. Adjacent loculated empyemas, it must be remembered, may coalesce. (4) The fourth

Fig. 1245. [illegible]
Fig. 1245. A. Central empyema, the lung compressed from all sides upon its root. Large combined empyema wrongly called general empyema. (From Lilienthal, Thoracic Surgery, W. B. Saunders Co.)
Fig. 1246. Distribution of empyemas. E, Mixed empyema. [illegible] (From Lilienthal, Thoracic Surgery, W. B. Saunders Co.)

form is the interlobar empyema which results from infection by that part of the lung where one lobe touches another (Figs. 1245-1246-1247).

Interlobar Empyema. If this condition exists without adhesions of lung tissue to the chest wall, Lilienthal advises (1) exposure through a free intercostal incision; (2) production of adhesions with extrapleural packings around the proposed site of drainage over which a rib has been resected and (3) evacuation of the pus at a later stage. Lilienthal comments: "While this may seem to be an operation of considerable magnitude it does not, in reality, cause shock and it may prevent opening into a bronchus, always a serious affair because of the possibility of inducing a chronic condition; it will also probably prevent the development of a large complicating empyema. The interlobar disease is well suited to the form of drainage secured by packing with gauze immediately after it has been opened at the second stage." The latter method of treating empyema at a primary operation has been recently tested thoroughly in the service of Doctor John F. Connors. Packing is, of course, one type of drainage and in some cases of empyema, especially in those of not too great size, is particularly suitable. Doctor Connors employs it even in extensive purulent pleuritis. It

Am. Surg., 1921. [illegible]

is necessary to resect enough ribs to get ample room for manipulation to break down adhesions when the cavity is anatomically complicated. The gauze must not be too firmly packed. It is removed on the second to the fourth day and as a rule need not be replaced. Coughing and straining are encouraged and the various complications of tube drainage are usually avoided. Manifestly if the interlobar empyema has become adherent to the parietal pleura, this operation can be performed in one sitting.

Bilateral Empyema. Should both sides be operated upon at the same time? The side most affected should be drained and the other side simply aspirated to

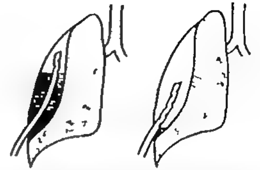


Fig. 1247. [illegible] (From Lilienthal, Thoracic Surgery, W. B. Saunders Co.)

be followed by repeated aspirations. Treatment should be directed to either intercostal incision with closed drainage or rib resection with packing. In the small loculated empyemas packing only should be resorted to.

SURGICAL TREATMENT OF CHRONIC EMPYEMAS

Estlander's Operation (1879)

If an empyema fails to heal after months and the etiology is not to be found in a removable cause, a plastic operation to obliterate the entire cavity is usually called for. This consists in mobilizing either the chest wall or the lung.

Ascertain the size of the cavity (x-ray, exploration, injection of bismuth paste). Resect subperiosteally the ribs overlying the empyema cavity, which should be covered by soft tissues only. The chest wall and pleura, it will be seen, are then made to collapse and the former is brought into apposition with the lung providing the pleura is not too thick. This may be an inch or more. The number of the ribs to be resected and the type of flap depend upon the extent of

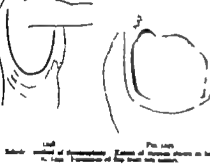


Fig. 1248. Fig. 1249.
Fig. 1248. Schede's method of thoracoplasty. [illegible]
Fig. 1249. Formation of flap [illegible]

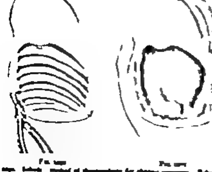


Fig. 1250. Fig. 1251.
Fig. 1250. Schede's method of thoracoplasty for chronic empyema. Subperiosteal resection of the ribs.
Fig. 1251. The cavity resulting after removal of the soft parts including your [illegible]

the thickness of the pleural cavity. The incision may be a small semilunar cut or a small U-shaped flap, depending upon the area to be exposed.

Schede's Thoracoplasty (1890)

In those instances where there exists a single, large and collapsible cavity Schede's extensive procedure may be resorted to (Figs. 1248-1249-1250-1251). It consists of removing not only the ribs but also all the soft tissues of the thoracic wall between the ribs and underneath them. Infiltration block anesthesia may be used (Fig. 1252).

Step 1. The incision begins in the upper part of the back, between the spinal column and the scapula, and descends to the lower border of the pleura, ascending again along the anterior axillary line and terminating under the border of the pectoralis major muscle. All the soft tissues of this extensive flap are dissected upwards, raising the scapula with it during the course of the dissection.

Step 2. All the ribs from the second down are resected together with their costal cartilages. After opening the pleura, the intercostal muscles and with them the thickened and infiltrated parietal pleura are removed. The visceral pleura which is much thickened in these cases is curetted with Volkmann's sharp spoon.

Step 3. Replace the skin flap. Introduce drainage tubes. It will be seen that the entire cavity then becomes filled with the collapsible soft tissues of the chest wall which become adherent to the visceral pleura, thus obliterating the cavity.

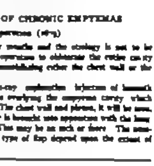


Fig. 1252. Infiltration anesthesia in resection of ribs in such conditions as Schede's [illegible] or thoracoplasty. The extent of [illegible] depends upon the number of ribs to be resected. The respective intercostal spaces are blocked [illegible] of the ribs. Preliminary to blocking the [illegible] the line of proposed skin incision [illegible] The nerves are injected upon the parietal pleura. About [illegible] of the anesthetic solution [illegible] depending on the points of injection.

Depage recommended a similar incision. Reflecting the skin flap first, the ribs are divided in the course of the incision and the thoracic wall is turned upward in its entire thickness. The ribs are then resected subperiosteally by incisions on the pleural surface as far as desired and the skin flap is replaced.

Comment. The patient should be put in the best possible condition before undergoing this extensive operation. Shock is marked. Prerequisites: Blood transfusion, rapid operating and good hemostasis. In much debilitated patients who cannot be subjected to the formidable procedure outlined, graded operations may be of value in the form of Estlander's operation.

Schede Operation

First Stage. Resect the eighth and ninth ribs. Make another incision a hand breadth above the first, through which resect the sixth and seventh ribs subperiosteally.

Fasten the flap thus obtained into the thoracic cavity. Usually the flap fastens itself to the lower portion of the cavity; the secretions discharge above it. Tampon the entire cavity.

Second Stage. Attack the remaining upper part of the cavity by resecting the upper ribs and the lower half of the scapula. Utilize the scapular muscles and skin for plastic repair.

Robinson Muscle Implantation Procedure

Robinson adopted Schede's procedure and advises muscle implantation, proceeding as follows:

Step 1. Make a U-shaped incision, beginning at the inferior angle of the scapula and extending downward to about the lower limits of the pleura and coursing upward anteriorly to terminate in the anterior axillary line at about the border of the pectoralis major muscle at the level of the nipple. The incision may be made to vary according to the location of the empyema cavity.

Step 2. Reflect skin and muscles upward. Cut the latissimus dorsi muscle between clamps. Resect the ribs subperiosteally. Ligate the intercostal vessels. Excise the thickened pleura. Dissect the latissimus dorsi muscle and displace it into the cavity. Replace the skin flap. Drain.

Comment. The entire attitude toward treatment of empyema is presently changing. It may be summarized in saying—use all means to prevent chronicity in empyema. Operate early to obviate the establishment of the abscess stage and conserve viability of the mediastinum. If the latter can be maintained with closed drainage, the healthy lung will fill up both thoracic spaces; not through empyemic expansion but through hypertrophy of lung tissue with tolerable displacement of the mediastinum.

Discussing the treatment of acute empyema, Evarts D. Graham recalls that "since the days of Hippocrates, empyema has been correctly regarded as an abscess of the pleural cavity which should be treated by drainage, for the same reason that drainage is employed for abscesses in other parts of the body. Nevertheless, the history of the treatment of this particular abscess is beclouded by the advocacy of special methods to be used for the accomplishment of the drainage" and that the principles underlying the treatment of the disease are:

1. Drainage, but with careful avoidance of an open pneumothorax during the period of active pneumonia.
2. Early sterilization and obliteration of the cavity and
3. Maintenance of the nutrition of the patient.

Continuous drainage by a closed method (Fig. 1093) (viz. one which does not permit the entrance of air into the pleural cavity) is, as Bunsis

pointed out, an old method. He says: "In recent years it has been frequently rediscovered and modified in nonessential details. One of its first champions was Cresswell Hewett who, in 1876, described his plan of 'subaqueous aspiration.'

"Theoretically," Graham argues, "the early establishment of continuous drainage with negative pressure should have the advantages of keeping the pleural cavity relatively free from liquid exudate and organisms, of aiding the expansion of the lungs as well as of avoiding an open pneumothorax with its attendant dangers. Practically, however, it seems doubtful if the results are appreciably better than with the method of repeated aspirations. There is also the risk, slight though it may be, that a delirious and unmanageable patient may, by interference with the apparatus or the drainage tube, allow air to enter his pleural cavity and may suffer from the effects of an open pneumothorax before it can be corrected.

Fig. 1093. So-called "closed drainage" of the pleural cavity [illegible] (Cook County Hospital.)

"There is still another danger if too much suction is used, the danger of tearing the lung. Not much suction is required to tear an edematous lung. In many cases this may result only in the creation of a small, temporary bronchial fistula, but in others hemorrhage may be produced. Other objections to most methods of closed drainage exist. One of these is the difficulty of keeping the tube and connections air-tight for more than a few days.

"Müller and others have also had difficulty in keeping it air tight. As soon as the tube becomes loosened a little, pus begins to collect around it; and if rubber dam or some similar material has been used to seal over the wound, the pus spreads around under it and macerates the skin. Still another objection is that with most forms of apparatus it is necessary for the patient to remain in bed. This is a distinct disadvantage because it is very desirable for all such patients to be up out of bed as soon as the heart and general condition will permit. If, however, a valvular tube of some kind is used (with a soft rubber flap on the end, the finger of a rubber glove, etc.), or such device as that advocated by van Eberts, or if a Pelletier bag is put on the tube as recommended by Bryant, then of course it will be possible for the patient to be out of bed. In spite of these remarks, however, in some cases continuous suction drainage seems to be of advantage. There are cases of empyema due to the rupture of putrid lung abscess into the pleura, associated with severe intoxication

of the patient in whom, for reasons already stated, it would be dangerous to create an open drainage, and for whom repeated aspirations do not suffice in relieving the intoxication. Moreover, cases of bilateral empyema are sometimes treated advantageously by continuous closed drainage.

"Open Drainage. From what has already been said it has become apparent that open drainage should never be performed during the formative stage of an empyema unless it is known that adhesions already exist. On the other hand, open drainage after the pleural infection has become a true abscess offers the advantage of free and adequate drainage without the necessity of any complicated apparatus. Our own preference in most cases of acute empyema is to carry on repeated aspirations until such time as the exudate has become frank, creamy pus and then to drain openly, usually by the resection of about an inch of one rib. In infants, smaller openings in general are more desirable than in older children or adults.

THE SO CALLED CLOSED METHOD OF INTERCOSTAL DRAINAGE

This procedure is usually limited to children and to very asthenic and ill adults.

As a preliminary procedure to the operation, take a No. 16 or 18 catheter, trocar and cannula; the latter should be of a size to permit the easy insertion of the catheter along its length. After this is accomplished, cut off the bulb end of the catheter. Make a second eye about one-half inch from the eye on the end of the catheter. Permit one and a quarter inches of the catheter to protrude from the cannula; this segment is to be introduced into the pleura. Mark the point so it will be plainly visible when necessary (Fig. 1094).

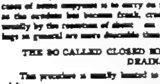


Fig. 1094. When the point [illegible] reaches the mouth of the cannula, 1¼ inches of the catheter should project from the distal end of the cannula. A secondary eye has been cut.

Step 1. Anesthetize the proper intercostal space.

Step 2. Make an incision a little longer than the diameter of the cannula and insert the trocar and cannula into the pleura for a short distance. Withdraw the trocar and place a finger over the mouth of the cannula.

Step 3. With a hemostat grasp the catheter and insert it in the cannula after removing the finger. When the marked point has been reached, withdraw the cannula.

Step 4. Place a second hemostat close to the cannula before removing the first one thus precluding the entrance of air into the pus-filled pleura.

Step 5. McEachern's method of closing the incision: the application of several layers of absorbent cotton which has been brushed with collodion until a collar one-half inch thick and five inches in diameter is built around the tube. The parts to which the dressing is applied are rendered clean

and dry by the use of ether. To drain the abscess cavity the pleural tube is passed through the cork into a bottle containing some antiseptic solution. McEachern's method of irrigation with Dakin's solution is considered a superior method.

Black Pleurisy (Pleurisy Masqué)

Occasionally while the physical signs and symptoms point to fluid in the chest, the aspirating needle fails to find it. The explanation for this was offered by Dubost in 1909. He called attention to this behavior in serous acute pleurisies. The reason for the fluid's failure to issue is that in a cavity composed of rigid walls the tension of the fluid about equals that of the atmosphere. If the tension of the fluid is less than that of the atmosphere no fluid will escape. To overcome this pass a second hollow needle along the first; atmospheric air will be admitted into the cavity and satisfactory aspiration will result.

Operative Treatment of Suppuration of the Mediastinum

In a recent communication[1] Lilienthal says: "In reality the danger of the draining of the mediastinal space is not more than in drainage of the pleura. The operation is more complicated and more difficult, but that is no reason for delay.

"The anterior part of the mediastinum can be reached in three ways:

1. Through the suprasternal notch (superior mediastinum).
2. Through the sternum itself.
3. Parasternally according to the location of the infection.

"In acute suppuration of the superior space the spread is apt to be rapid and the safest thing is to make drainage through the suprasternal region. This is done through a median incision with or without the addition of a cross cut at its lower limit. The mediastinum should be entered by slow careful dissection in order that neither great vessels nor pleurae be injured. Having entered the mediastinum it will be noted that with each strain or cough the pleural membranes will approximate and the field between them will be forced out. A moderate-sized soft tube should be inserted as far as required and permanent suction instituted.

It may be necessary to split a greater part of the manubrium and gladiolus longitudinally with or without resection in order to gain perfect drainage (Milton operation). One must be certain that the posterior periosteum has been divided. In any acute case the sudden audible snapping together of the pleurae when the patient strains or coughs is most striking as observed through the wound. As the wound granulates, the movements decrease and finally disappear.

"It sometimes happens that the main part of the anterior mediastinal abscess lies in such a location that it can be reached parasternally. A parasternal longitudinal incision should be made (beware of mammary artery), costal cartilages removed and then careful blunt dissection performed into the infected part, always remembering that there is no certain way of telling whether the right

[1] New York State Jour. of Medicine, 1932.

anterior pleura may extend over to the left or the left anterior fold over to the right.

Posterior mediastinitis may be drained by a major operation, although with less danger than that of draining the anterior space. The procedure is to incise just beyond the long spinal muscles, to divide the [illegible] if the upper part of the space must be reached and to continue downward as far as necessary, resecting enough ribs to afford wide access. Wounds of this kind may have to be packed, because there is a strong tendency for the ends of the resected ribs to approach each other. This can be avoided by cauterizing the ends with lye or trichloracetic acid. In making a lower posterior mediastinotomy on the left side the right pleura which normally extends across the midline lies in this region is in danger unless great care is exercised. If this accident has occurred it will always announce itself by a characteristic sucking sound. Dissection must be careful and digital exploration to find the aorta must be made. It lies toward the left of the vertebral bodies. In right lower posterior mediastinotomy the pleura is always in the way and must be guarded. Having reached pus, the limits of the cavity should be explored if possible, and packed with gauze.

It should be repeated here that the mortality already referred to in operating for the relief of infections of the mediastinum is entirely unwarranted. To wait for a sure diagnosis may mean the loss of the patient's life. At the same time it should be emphasized that one to whom these operations are unusual would do well to avail himself of the assistance of a trained thoracic surgeon.

SURGICAL TREATMENT OF PULMONARY TUBERCULOSIS

Historical Notes. Early attempts to treat pulmonary tuberculosis by surgical measures failed. In the eighteenth century, E. Barry, Bartlapen, David, Pousse, Hastings and others tried to evacuate tuberculous cavities as they would other abscesses. Von Mosler, in the first half of the nineteenth century, tried to inject pulmonary parenchyma carbolic acid or tincture of iodine into tuberculous cavities. Later Block, Gluck, Macewen and others tried extensive pulmonary resections. These procedures had to be abandoned because of the very high mortality. Freund proposed chondrotomy of the first rib without satisfactory results.

The keynote to success in the surgical treatment of pulmonary tuberculosis is collapse and immobilization of the affected lung to insure functional rest. This objective is reached by the following procedures:

1. Artificial pneumothorax (the introduction of a gas between the two layers of the pleura) (Figs. 1133, [illegible]).
2. Pneumolysis—(a) external pneumolysis, where the separation is effected between the inner surface of the thoracic cage and the outer layer of the pleura and rarely (b) internal pneumolysis between the two layers of the pleura.
3. Extrapleural thoracoplasty—removal of part of the wall of the chest.
4. Operations on the phrenic nerve (crushing, division, resection, avulsion) to effect immobilization of the diaphragm, in an elevated position, compressing the lung.

Each of these methods has its special indications. Some may be combined.

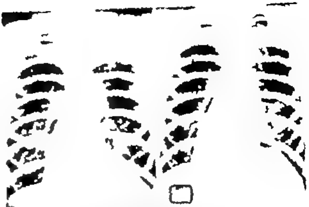


Fig. 1133 Fig. 1134

Fig. 1133. [illegible] Left mid [illegible] lobe [illegible].
Fig. 1134. Same as preceding after pneumothorax treatment. (Municipal Tuberculosis Sanitarium, Chicago.)

Fig. 1135 Fig. 1136

Fig. 1135. [illegible] Large tuberculous cavity before pneumothorax treatment.
Fig. 1136. [illegible] Same as preceding. Complete closure of cavity following pneumothorax treatment. (Municipal Tuberculosis Sanitarium, Chicago.)

All are to be resorted to in conjunction with recognized hygienic measures. Fit the methods to the patient and not the patient to a pet method.

Historical Notes. The first pneumothorax by incision (open), was induced by Cowan in [illegible], and the first closed one (by puncture) by Caley in 1882. Forlanini suggested the method three years before. It was later championed in America by Murphy, Robell, Lemke and Kelly, in Denmark by Saugmann and in Germany by Brauer, Kummel, Sprengler, von Muralt, A. Schmidt, Kuthe and Dumke [illegible] and popularized the method.

Extrapleural thoracoplasty was conceived independently of each other by Quincke in 1888 and C. Spengler in 1890. It was sponsored in Germany especially by Brauer who recognized that a pneumothorax [illegible] to carry with [illegible]

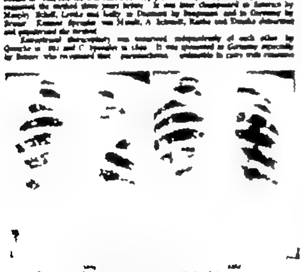


Fig. 1137 Fig. 1138

Fig. 1137. [illegible] Lesion right middle lobe before pneumothorax.
Fig. 1138. Same as preceding after pneumothorax treatment. (Municipal Tuberculosis Sanitarium, Chicago.)

pleural adhesions. In collaboration with Friedrich, he devised an operation in which the ribs, from the second to the tenth, are completely removed on one side each one from the spinal column to the costochondral junction. To offset its danger Wilms proposed the [illegible] in which only 3 to [illegible] cm of the ribs were removed posteriorly and [illegible] similar small portion from the costal cartilages in front.

Sauerbruch deserves the credit for establishing the method on a comparatively safe basis. His method of paravertebral extrapleural thoracoplasty stands as a compromise between the Brauer-Friedrich and Wilms procedures.

Extrapleural pneumolysis was first recommended by Tuffier following a report by Schlange of a complete success of compression in a chronic abscess or bronchiectasis. Tuffier separated the adherent pleura from the internal surface of the thorax and tamponed the resulting extrapleural cavity first temporarily, then permanently, with autoplastic fat and later successively with bismuth paste or paraffin. Paraffin plombage was devised by C. Baer.

Stuertz, in 1911, proposed and performed phrenicotomy or phrenicotomy. Sauerbruch almost immediately followed suit. In 1913, Sauerbruch reported his first results in five cases. Goetze, in 1922, proposed phrenicectomy, or avulsion of the nerve

Phrenicoexeresis, or avulsion of the phrenic nerve, was advised by Felix who showed that some of the operations on the phrenic nerve take into consideration its anatomy especially the existence of the accessory phrenic nerves in [illegible] per cent of the cases. He suggested drawing out of at least [illegible] cm. of the nerve thus breaking all connections with the possibly present accessory phrenic nerve.

INDICATIONS FOR VARIOUS OPERATIVE PROCEDURES IN THE TREATMENT OF PULMONARY TUBERCULOSIS

Thoracoplasty

This is indicated in cases of:

(a) Chronic unilateral fibrosing tuberculosis with rigid mediastinum, good heart, good resistance and, preferably in a patient running an afebrile course.

(b) Pyopneumothorax which has not responded to other treatment.

(c) Cavities which failed to close under pneumothorax or phrenicectomy or where these procedures were contraindicated on account of the danger of perforation.

(d) Severe recurrent hemorrhage where other treatment has failed.

(e) The positive sputum case which persists in spite of other compression measures.

(f) Bronchiectasis where phrenicectomy has been of no value.

(g) In bilateral cases where there is evidence of regressive change in the healthier lung. If there is sufficient normal lung tissue in the lower lobe to maintain respiration, it is recommended by some to use partial upper thoracoplasty.

(h) It has been successfully used to prevent re-expansion after a prolonged pneumothorax.

(i) Pulmonary abscess with uncollapsed lower difficulties.

(j) Acute, rapidly progressive unilateral disease may be added after all other forms of treatment have failed.

Thoracoscopy and Cauterization of Adhesions

Many authors maintain that thoracoscopy is not employed often enough as a means of diagnosis to evaluate the pathologic changes present in the pleural cavity or to ascertain the cause and extent of adhesions which might interfere with pneumothorax treatment.

If pleural adhesions are suspected much time may be conserved by examining the surfaces of the pleura instead of instigating a long therapeutic test. It is essential that the surgeon be in possession of many facts concerning adhesions so that he will be in a position to judge whether or not pneumothorax will be beneficial.

Thoracoscopy may be useful in ascertaining the presence of pleural atrophy or an effusion which may occur during pneumothorax treatment. It is useful also in the diagnosis of nontuberculous pulmonary or pleural pathology.

Where adhesions interfere with the course of pneumothorax or oleothorax, cauterization or section is indicated. As a rule small [illegible] adhesions are easily divided. Flat extensive adhesions involving a great deal of pleural and [illegible] appearance suggests their likelihood of containing [illegible] into

parenchyma of the lung tissue or cavity should be divided very cautiously if at all.

Multiple Intercostal Neurectomy

This procedure has the advantage of being comparatively free from operative dangers and is not followed by disfigurement. By injecting alcohol instead of cutting the nerve it may be made temporary. The chief objection to it lies in the fact that it immobilizes the ribs only and that it does not reduce appreciably intrapleural pressure or lead to collapse of the lung. The operation is indicated in a few rare cases where the lesion does not justify a thoracoplasty or when the patient's condition is too weak for it.

Apicolysis

This operation is indicated in the presence of large apical cavities which failed to close following other treatment, and where thoracoplasty is contraindicated. Bilateral apical cavitation where the lower part of the lungs is normal is a good example. The operation was originated by Schlange in 1907 and consists of extrapleural pressure applied directly over the cavity. The upper lobe is usually the operative site; approach is made through the anterior chest wall, through the third interspace. Some surgeons remove parts of the second and third ribs; others merely separate the ribs to gain access. This part of the lung is kept collapsed by stripping the pleura from the ribs and introducing packing between the ribs and pleura. The packing may consist of paraffin, gauze, fat, muscle or rubber dam. The operation is more popular on the European continent than in this country. It has been successfully used as an adjunct to thoracoplasty with good success in closing cavities.

Anterolateral Costectomy

If cavities still persist after thoracoplasty has been employed, further sectioning of ribs will often result in additional reduction in the size of the hemithorax to accomplish the collapse.

Pneumothorax

The indications for pneumothorax in tuberculosis are taken up in detail under that section.

DIRECT DRAINAGE

The cavity to be drained is treated in the same manner as a nontuberculous lung abscess (p. [illegible]). Drainage is accomplished with more facility and safety when the cavity is close to the periphery of the lung with definite overlying adhesions to the wall of the thorax so that these adhesions cannot be divided (thus preventing an effective pneumothorax).

Cavities which are large and thin-walled respond satisfactorily to this type of treatment. In these cases a certain amount of collapse follows drainage which results in healing by granulation. Beneficial results follow drainage in cases which are characterized by large bilateral cavities which are too involved to allow any extensive collapse measures.

Thoracotomy (p. [illegible]) may be performed through an interspace or a small part of the rib may be removed. To prevent the escape of pus into the general pleural cavity, the parietal pleura should be sutured to the visceral pleura if they are not already adherent. A rubber or some other drain is inserted directly into the cavity.

THORACOSCOPY AND INTRAPLEURAL PNEUMOLYSIS

Thoracoscopy is a diagnostic procedure which was developed in connection with intrapleural pneumolysis or division of adhesions.

In 1913, Jacobaeus reported several cases where he had successfully changed an ineffective pneumothorax by the intrapleural division of the adhesions. Since then, the procedure has been used by a number of surgeons with modifications of apparatus and technic. At first it was used only in the Scandinavian countries. A little later Unverricht in Germany used it extensively and improved the apparatus. It is comparatively new in France. Exploration was accomplished using an endoscope by Jacobaeus. Following this, a cannula was introduced close to the adhesion through which access was obtained for the cautery.

Indirect, right-angle vision is provided by a lens and mirror on Jacobaeus thoracoscope (Figs. [illegible] and [illegible]). The method had many objectionable characteristics: the right-angle view is much less distinct than direct vision; the light on the thoracoscope is rather distant from the operative field resulting in the blurring of the lenses by blood and vapor; two instruments are rather hard to control. There have been many attempts to devise direct vision instruments through which cautery may be done.

In the direct vision thoracoscope, fumes, the result of cauterization, pass out immediately; the surgeon's coordination is better, resulting in suction being efficiently done at any time. The movable light is an advantage.

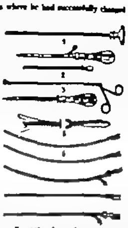


Fig. [illegible]. Lens thoracoscope and Jacobaeus apparatus for technique and exploration of the thoracic cavity and for severing of adhesions by means of cautery electrodes. The set of instruments consists of [illegible] trocar; [illegible] trocar with cannula; [illegible] for introducing cautery electrode; [illegible] forceps with special handle for attaching to flexible cable; [illegible] cautery electrode with curved narrow blade; [illegible] cautery electrode with rounded blade; [illegible] straight cautery electrode; [illegible] rubber tubes for cautery electrodes.

The number, type and location of the adhesions are determined by the use of the thoracoscope and x-ray. The patient is prepared as for any other surgical procedure. The thoracoscope should be introduced to one side of the adhesion to be divided so that the cautery may be brought into position at right angles to the adhesion. It may be inserted through a small incision or puncture between two ribs.

Diagnostic thoracoscopy is a simple procedure and practically free from danger. It is being used more and more. It is a valuable means of ascertaining whether or not pleural symphysis is taking place in a given case of pleurisy which is recovering. The presence of fine filaments in the field from visceral to parietal pleura calls for immediate pneumothorax or oleothorax. The sectioning of adhesions entails some technical considerations.

It is important for the surgeon to have a thorough knowledge of the anatomy and position of the adhesions. In 1930, Maurer classified adhesions into several main groups. Recently formed adhesions present no enlargement of either the thoracic or pulmonary insertion. Section is safe and easy, but on account of their tendency to stretch, the procedure is deceiving. Adhesions with enlarged thoracic insertions are rare. Adhesions with enlargement of the pulmonary insertion occur more frequently. Both varieties are indicative of old and tough

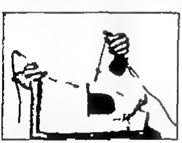


Fig. [illegible]. Position for pleuroscopy [illegible] [illegible]. The [illegible] of pleural [illegible] and [illegible] so arranged that [illegible] pneumothorax with adhesion [illegible]. In places where [illegible] are generally inserted, perforated rubber [illegible] are interposed [illegible] of easy introduction and manipulation of operating instruments which may be observed through a window in the [illegible].

sized adhesions. Great care must be exercised where the adhesions have the pulmonary insertion, as parts of the lung tissue are likely to be engulfed in the enlargement rendering them liable to injury. In some instances, lung tissue or a cavity extends into such an adhesion practically to the parietal pleura. This variety of adhesion is most common. Empyema or hemorrhage following the operation is due to incising the adhesion too far from the wall of the thorax. In cordlike adhesions which are more than one-half centimeter in diameter care must be exercised as a large blood vessel may be coursing in it.

The broad membranous band type of adhesion presents the most difficulty to section. Their exact width and the structures contained are difficult to determine. A sound is used by some surgeons to ascertain the width; other surgeons do the sectioning in multiple stages.

A galvanocautery was used by Jacobaeus and others for dividing adhesions until recently. Many have since substituted the diathermy knife. Surgical cutting by means of the high frequency electrode was used very successfully by Maurer in France and Matson in America.

The high frequency cutting knife produces little coagulation necrosis, fumes or smoke. It penetrates the cellular structures so that spontaneous separation takes place. It should be done slowly and carefully; large blood vessels should be electrocoagulated. One should be thoroughly conversant with the action of the different kinds of coagulation and cutting currents.

Adhesions should be severed close to the wall of the thorax.

Maurer recommends dissecting the adhesions from the parietal pleura. His procedure necessitates the anesthetizing of the attachment of the adhesions on account of the sensitivity of the parietal pleura which is directly incised. A needle 5 cm long together with a specially designed syringe is used for this purpose by Maurer. Care is exercised to avoid injury to an intercostal vessel.

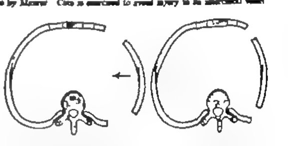


Fig. [illegible]. [illegible] anterior and posterior rib resect[ion] [illegible] the capacity of the thorax is [illegible] [illegible] by pushing the remaining sections of the resected ribs towards the median line (Sauerbruch). (Courtesy of Dr. Howard Lilienthal.)

Any number of adhesions may be sectioned at one sitting if the condition of the patient is good. When through, remove the thoracoscope; close the incision by sutures. Apply a tight dressing to prevent surgical emphysema. A day or so later a pneumothorax refill is given to prevent new adhesion formation.

EXTRAPLEURAL THORACOPLASTY

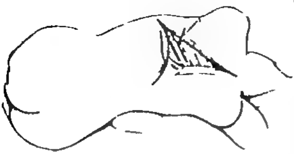
A number of operative procedures have been devised for the purpose of collapsing the lung. Wilms removed portions of many ribs posteriorly and anteriorly for the purpose of reducing the capacity of the thoracic cavity (Fig. [illegible]). A number of other methods have been employed to accomplish the same result. Sauerbruch's procedure in which many ribs, including the first, are shortened by paravertebral resection, is the most satisfactory. More important than the collapse is the immobilization which follows this procedure and which is aided by a bridge of bone which forms between the divided ribs uniting them into one rigid whole. If one adds to this the paralysis of the diaphragm by phrenic nerve resection or avulsion, the thorax is effectively placed at rest, a condition essential to the healing of tuberculosis. The operation is not a very difficult one and may be done by one not equipped with special knowledge of and experience in thoracic surgery.

The results of thoracoplasty, properly performed in selected cases, are ex-

relief. The best age to perform total thoracoplasty is between 3 and 5 years (Nissen).

Phrenicotomy precedes the operation (about [illegible] months prior). The cavities are emptied by postural treatment. It is assumed that the patient is placed in an optimum condition to undergo the ordeal. One morphine an hour before the operation.

Anesthesia. Local and regional nerve block (novocaine one half per cent). This may be supplemented by ethylene-oxygen or cyclopropane. A competent



[illegible]. Position of patient [illegible] thoracoplasty. (Courtesy of Dr Howard Lilienthal)

anesthetist [illegible] is essential in this form of surgery. Lilienthal does not consider that ether properly administered acts as a deleterious irritant in tuberculosis of the lung. Marion [illegible] avertin [illegible] amytal preliminary to general anesthesia.

Step [illegible]. Position on the Table. The patient [illegible] placed on the sound side. The operative area [illegible] forward. The operation may be performed in a number of stages depending upon the exigencies of the case.

Incision. The [illegible] paravertebral [illegible] of the case (Fig. [illegible]). The incision passes parallel downward as shown in the illustration (Fig. [illegible]) then deepened. The muscles are rapidly dissected from the thoracic wall [illegible] sharp scalpel and displaced by means of retractors.

Step [illegible]. The most prominent rib in the wound [illegible] selected for the first resection. An incision with [illegible] scalpel or with [illegible] sharp periosteotome [illegible] made along the surface parallel with the line of the rib and by scraping strongly with [illegible] that part of the bone [illegible] cleared. Ten to [illegible] cm segments of the lower ribs are resected the resection being flush with the transverse process. The later [illegible] Heidelberg advised the posterior resection in three stages at intervals of seven to ten days.

Step 3. The nerves are identified and infected with [illegible] few drops of novocaine and then crushed. This eliminates postoperative pain.

Step 4. The remaining anterolateral segments are removed through [illegible] axillary incision, in two stages. (Fig. [illegible]) Separate the periosteum from

Fig. [illegible]. Posterior [illegible] thoracoplasty in three stages [illegible] (Heidelberg in Lewis' Practice of Surgery)

the anterior ends of the ribs. Section the ribs at the costochondral junction. The mobilized anterior end of the rib is used as [illegible] lever (Fig. [illegible]) the

periosteum [illegible] separated from the rib to the portions lying underneath the posterior edge of the wound. For the removal of ribs [illegible] rib shears are excellent. Little difficulty [illegible] encountered in resecting the ribs until the second and first are reached. Even the second presents no particular obstacle.

[illegible]. [illegible] (Heidelberg [illegible] Practice of Surgery [illegible] Prior Co.)

The first rib [illegible] situated very deeply and far forward and the subclavian vessels are in close relation to it. The brachial plexus also is in close proximity.

Since the first rib is so deeply placed and difficult to approach from

behind, and believing that the screw guillotine principle will exhibit the greatest power in the smallest manner, Lilienthal and Tiemann constructed an instrument after Lilienthal's drawings which proved of much value (Fig. [illegible]). The guillotine consists of [illegible] shaft with [illegible] right-angled bend at the [illegible]

Fig. [illegible]. [illegible] thoracoplasty [illegible] (Heidelberg in Lewis' Practice of Surgery [illegible] Prior Co.)

[illegible] to be passed behind the bared rib as [illegible] guard against injuring contiguous vessels and nerves. Toward this guard [illegible] powerful screw forces [illegible] long-beveled [illegible] which is checked by [illegible] metal stop just before it reaches the guard and after it has passed through the rib. The slow and

[illegible] Lilienthal guillotine for cutting the first rib. (Courtesy of Dr Howard Lilienthal)

steady screw action of the guillotine is much less disturbing to [illegible] patient being operated upon under local anesthesia than the application of forceps or shears worked by handles which of necessity must cause [illegible] jarring or other [illegible] motion of the patient [illegible] body frame.

Step 5. Having completed the multiple resections, introduce [illegible] drainage

parenchyma of the lung tissue or cavity should be divided very cautiously if at all

Multiple Intercostal Neurectomy

This procedure has the advantage of being comparatively free from operative dangers and is not followed by disfigurement. By injecting alcohol instead of cutting the nerve it may be made temporary. The chief objection to it lies in the fact that it immobilizes the ribs only and that it does not reduce appreciably intrapleural pressure or lead to collapse of the lung. The operation is indicated in a few rare cases where the lesion does not justify a thoracoplasty or when the patient's condition is too weak for [illegible]

Apicolysis

This operation is indicated in the presence of large apical cavities which failed to close following other treatment, and where thoracoplasty is contraindicated. Bilateral apical cavitation where the lower part of the lungs is normal is a good example. The operation was originated by Schlange in 1907 and consists of extrapleural pressure applied directly over the cavity. The upper lobe is usually the operative site. Approach is made through the anterior chest wall, through the third interspace. Some surgeons remove parts of the second and third ribs; others merely separate the ribs to gain access. This part of the lung is kept collapsed by stripping the pleura from the ribs and introducing packing between the ribs and pleura. The packing may consist of paraffin, gauze, fat, muscle or rubber dam. The operation is more popular on the European continent than in this country. It has been successfully used as an adjunct to thoracoplasty with good success in closing cavities.

Anterolateral Costectomy

If cavities still persist after thoracoplasty has been employed, further sectioning of ribs will often result in additional reduction in the size of the hemithorax to accomplish the collapse.

Pneumothorax

The indications for pneumothorax in tuberculosis are taken up in detail under that section.

DIRECT DRAINAGE

The cavity to be drained is treated in the same manner as a nontuberculous lung abscess (p. [illegible]). Drainage is accomplished with more facility and safety when the cavity is close to the periphery of the lung with definite overlying adhesions to the wall of the thorax so that these adhesions cannot be divided (thus preventing an effective pneumothorax).

Cavities which are large and thin walled respond satisfactorily to this type of treatment. In these cases a certain amount of collapse follows drainage which results in healing by granulation. Beneficial results follow drainage in cases which are characterized by large bilateral cavities which are too involved to allow any extensive collapse measures.

Thoracotomy (p. [illegible]) may be performed through an interspace or a small

part of the rib may be removed. To prevent the escape of pus into the general pleural cavity the parietal pleura should be sutured to the visceral pleura if they are not already adherent. A rubber or some other drain is inserted directly into the cavity.

THORACOSCOPY AND INTRAPLEURAL PNEUMOLYSIS

Thoracoscopy is a diagnostic procedure which was developed in connection with intrapleural pneumolysis or division of adhesions.

In 1913, Jacobaeus reported several cases where he had successfully changed an ineffective pneumothorax by the intrapleural division of the adhesions. Since then, the procedure has been used by a number of surgeons with modifications of apparatus and technic. At first it was used only in the Scandinavian countries. A little later Unverricht in Germany used it extensively and improved the apparatus. It is comparatively new in France. Exploration was accomplished using an endoscope by Jacobaeus. Following this, a cannula was introduced close to the adhesion through which access was obtained for the cautery.

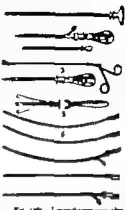


Fig. [illegible]. Laparothoracoscope after Jacobaeus Unverricht [illegible]

Indirect, right-angle vision is provided by a lens and mirror on Jacobaeus' thoracoscope (Figs. [illegible]). The method had many objectionable characteristics: the right-angle vision is much less distinct than direct vision; the light on the thoracoscope is rather distant from the operative field resulting in the blurring of the lenses by blood and vapor; two instruments are rather hard to control. There have been many attempts to devise direct vision instruments through which cautery may be done.

In the direct vision thoracoscope, fumes, the result of cauterization, pass out immediately; the surgeon's coordination is better, resulting in section being efficiently done at any time. The movable light is an advantage.

The number, type and location of the adhesions are determined by the use of the thoracoscope and X-ray. The patient is prepared as for a minor surgical procedure. The thoracoscope should be introduced to one side of the adhesion to be divided so that the cautery may be brought into position at right angles to the adhesion. It may be inserted through a small incision or puncture between two ribs.

Diagnostic thoracoscopy is a simple procedure and practically free from danger. It is being used more and more. It is a valuable means of ascertaining whether or not pleural symphysis is taking place in a given case of pleurisy which is recovering. The presence of fine filaments in the fluid from visceral to parietal pleura calls for immediate pneumothorax or aleothorax. The sectioning of adhesions entails more technical consideration.

It is important for the surgeon to have a thorough knowledge of the anatomy and position of the adhesions. In 1930, Maurer classified adhesions into several main groups. Recently formed adhesions present no enlargement of either the thoracic or pulmonary insertion. Section is safe and easy, but on account of their tendency to stretch, the procedure is deceiving. Adhesions with enlarged thoracic insertions are rare. Adhesions with enlargement of the pulmonary insertion occur more frequently. Both varieties are indicative of old and tough-

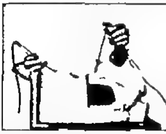


Fig. [illegible]. [illegible]

ened adhesions. Great care must be exercised when the adhesions have the pulmonary insertion, as parts of the lung tissue are likely to be engulfed in the enlargement rendering them liable to injury. In some instances, lung tissue or a cavity extends into such an adhesion practically to the parietal pleura. The variety of adhesion is most common. Empyema or hemorrhage following this operation is due to incising the adhesion too far from the wall of the thorax. In cordlike adhesions which are more than one-half centimeter in diameter care must be exercised as a large blood vessel may be coursing in.

The broad membranous band type of adhesion presents the most difficulty in section. Their exact width and the structures contained are difficult to determine. A sound is used by some surgeons to ascertain the width; other surgeons do the sectioning in multiple stages.

A galvanocautery was used by Jacobaeus and others for dividing adhesions until recently. Many have since substituted the diathermic knife. Surgical cutting by means of the high frequency electrode was used very successfully by Maurer in France and Matson in America.

The high frequency cutting knife produces little coagulation, smoke, fumes or smoke. It penetrates the cellular structures so that spontaneous repair can take place. *It should be done slowly and carefully;* large blood vessels should be electrocoagulated. One should be thoroughly conversant with the action of the different kinds of coagulation and cutting currents.

Adhesions should be sectioned close to the wall of the thorax.

Maurer recommends dissecting the adhesions from the parietal pleura. The procedure necessitates the anesthetizing of the attachment of the adhesion on account of the sensitivity of the parietal pleura, which is directly incised. A needle [illegible] cm long together with a specially designed syringe is used for this purpose by Maurer. Care is exercised to avoid injury to an intercostal vessel.

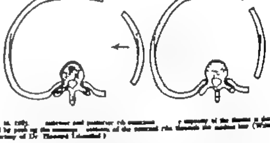


Fig. [illegible]. [illegible] anterior and posterior rib resection [illegible] capacity of the thorax is diminished by [illegible] (Courtesy of Dr. [illegible])

Any number of adhesions may be sectioned at one sitting if the condition of the patient is good. When through, remove the thoracoscope; close the incision by sutures. Apply a tight dressing to prevent surgical emphysema. A day or so later a pneumothorax refill is given to prevent new adhesion formation.

EXTRAPLEURAL THORACOPLASTY

A number of operative procedures have been devised for the purpose of collapsing the lung. When removed portions of many ribs posteriorly and anteriorly for the purpose of reducing the capacity of the thoracic cavity (Fig. [illegible]). A number of other methods have been employed to accomplish the same result. Sauerbruch's procedure in which many ribs, including the first, are shortened by paravertebral resection, is the most satisfactory. More important than the collapse is the immobilization which follows this procedure and which is aided by a bridge of bone which forms between the divided ribs uniting them into one rigid whole. If one adds to this the paralysis of the diaphragm by phrenic nerve resection or avulsion, the thorax is effectively placed at rest, a condition essential in the healing of tuberculosis. The operation is not a very difficult one and may be done by one not equipped with special knowledge of and experience in thoracic surgery.

The results of thoracoplasty properly performed in selected cases, are ex-

critical. The best age to perform total thoracoplasty is between 5 and [illegible] years (Nissen).

Phrenicotomy precedes the operation (about [illegible] months prior). The cavities are emptied by postural treatment. It is assumed that the patient is placed in an optimum condition to undergo the ordeal. Give morphine an hour before the operation.

Anesthesia. Local and regional nerve block (novocaine one half per cent). This may be supplemented by ethylene-oxygen or cyclopropane. A competent

Fig. [illegible]. Position [illegible] thoracoplasty. (Courtesy of Dr. Howard Lilienthal.)

anesthetist [illegible] in this form of surgery. Lilienthal does not consider that ether properly administered acts as [illegible] irritant in tuberculosis of the lung. Nissen holds various morphia preliminary to general anesthesia.

Step [illegible]. Position on the Table. The patient is placed on the sound side. The operative arm is drawn forward. The operation may be performed in a number of stages depending upon the condition of the case (Fig. [illegible]).

Incision. The [illegible] paravertebral division of the tissues (Fig. [illegible]). The incision passes parallel downward as shown in the illustration. It is then deepened. The muscles are rapidly dissected from the thoracic wall with a sharp scalpel and displaced by means of retractors.

Step [illegible]. The most prominent rib in the wound is selected for the first resection. Its periosteum is [illegible] scalpel or with a sharp periosteotome is made along the surface parallel with the line of the rib and by wiping strongly with gauze the part of the bone is cleared. Ten to 15 cm. segments of the lower ribs are resected, the resection being flush with the transverse process. The late Dr. Carl A. Hedblom advised that posterior resection in three stages at intervals of seven to ten days.

Step 3. The nerves are identified and injected with a few drops of novocaine and then crushed. This diminishes postoperative pain.

Step 4. The remaining anterolateral segments are removed through a mid-axillary incision, in two stages. (Fig. [illegible].) Separate the periosteum from

Fig. [illegible]. Posterior extrapleural thoracoplasty in three stages [illegible] [illegible]

the anterior ends of the ribs. Section the ribs at the costochondral junctions. The mobilized anterior end of the rib is used as a lever (Fig. [illegible]). The

periosteum is separated from the rib to the portion lying underneath the posterior edge of the wound. For the removal of ribs Shoemaker rib shears are excellent. Little difficulty is encountered in resecting the ribs until the second and first are reached. Even the second presents no particular obstacle.

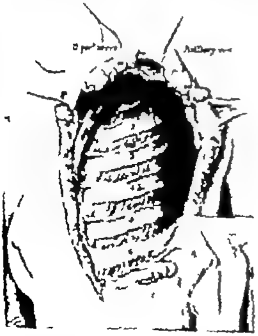


Fig. [illegible]. Completed thoracoplasty. Anterolateral operation. [illegible] [illegible] (Hedblom in Lewis: Practice of Surgery. W. F. Prior Co.)

The first rib is situated very deeply and far forward and the subclavian vessels are in close relation to it. The brachial plexus also is in close proximity.

Since the first rib is so deeply placed and difficult to approach from

behind, and believing that the screw guillotine principle [illegible] the greatest power in the simplest manner, Lilienthal and Tiemann constructed an instrument after Lilienthal's drawings which proved of much value (Fig. [illegible]). The guillotine consists of a shaft with a right-angled hook at the ex-

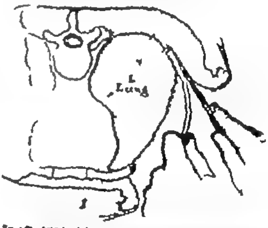


Fig. [illegible]. Anterolateral thoracoplasty, showing method of [illegible] [illegible] (Hedblom in Lewis: Practice of Surgery. W. F. Prior Co.)

tremity to be passed behind the first rib to guard against injuring adjacent vessels and nerves. Toward this guard a powerful screw forces a long-bladed osteotome which is checked by a metal stop just before it reaches the guard and after it has passed through the rib. The slow and

Fig. [illegible]. Lilienthal's guillotine for cutting the first rib. (Courtesy of Dr. Howard Lilienthal.)

steady screw action of the guillotine is much less disturbing to a patient being operated upon under local anesthesia than the application of forceps or shears worked by handles which of necessity must cause jarring or other forced motion of the patient's bony frame.

Step 5. Having completed the multiple resections, introduce a drainage tube

with many frenotres in the depths of the wound at about the level of the third rib, its lower extremity projecting from the inferior angle. Suture the muscles over the tube with chromicized catgut (interrupted). Approximate the fascia. A narrow packing of gauze is placed in the upper extremity of the wound down to the resected first rib, the end of the packing protruding from the upper wound angle. This gauze is put in as safeguard in case of even the slightest infection.

Step 8. Approximate the skin edges with interrupted sutures or with metal clips and hold the dressings firmly in place with broad adhesive straps.

Sauerbruch's Paravertebral Extrapleural Thoracoplasty

Resection must comprise 10 to [illegible] ribs, including the first rib. The paravertebral stumps must be very short, not longer than the transverse processes of the

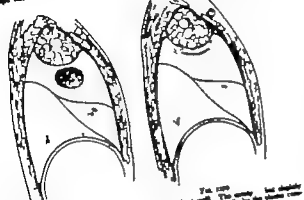


Fig. 1269. [illegible] Fig. 1270. [illegible] (Courtesy of Dr. Lilienthal, Thoracic Surgery, W. B. Saunders.)

vertebrae. The diameter of the thorax is not reduced, unless the operation begins in the middle of the axillary line, and it is materially reduced, when the posterior axillary line is reached. It should be performed in two stages, beginning with the eleventh or tenth rib to the sixth and continuing, about three weeks later with the fifth to first rib.

Partial thoracoplasties may be used in conjunction with artificial pneumothorax, also partial [illegible].

According to W. Neumann, thoracoplasty should not be considered if the tuberculosis has lasted for more than two to four years. According to [illegible]

brech, conservative treatment is given [illegible] fair chance if it is continued for one to two years. The preferred ages for operation are between 20 and 35 years. After the age of 50, thoracoplasty should be considered only exceptionally.

EXTRAPLEURAL PNEUMOLYSIS

Lilienthal was first to point out the importance of saving healthy lung tissue in operations for tuberculosis. T[illegible] [illegible] certain degree of pulmonary collapse, an attempt is made to free the normal connections between the parietal pleura and the rigid chest wall, with or without the endothoracic fascia. Lilienthal questions its usefulness in diseases of the lower thorax. At the apex, the operation can be done with comparative facility and the superior portion of the upper lobe can be depressed extrapleurally leaving [illegible] large space to be filled with some substance to prevent re-expansion.

Apicolysis is the term used to designate that form of pneumolysis, the lung is pressed downward and if there are no adhesions the infiltrated or cavitated apex may be, as it were, transported as [illegible] bolus upon healthy lung, the latter being compressed far more than the diseased part (Figs. [illegible]). [illegible] the compression of the apex increases because of the gradual elastic pressure of the healthy lung below. The full benefit of the apicolysis may not at once appear. When adhesions are present binding the lung below to the chest wall apicolysis will secure [illegible] much more thorough compression with good [illegible] obliteration of the apical cavities.

In [illegible] personal communication Dr. Howard Lilienthal writes: "My method of upper thoracoplasty combined [illegible] apicolysis is ordinarily preferred to the apical one which you have," referring to the procedure presently described.

Calerio's Modification of Proust, Maurer and Rolland's Apicolysis Thoracoplasty

In 1891 Tuffier used pleuro-parietal detachment in the treatment of tuberculosis of the lung. Twenty years later the same author performed compression of the apical cavities with transplantation of fat after first resorting to pleuroparietal detachment. This opened [illegible] wide avenue for the progress of surgery of the tuberculous lung and formed the basis for what was later termed apicolysis [illegible] [illegible] [illegible] [illegible] [illegible]

intercostal nerves (Lewin, Rankow), scalenotomy (Gregoire, Bolo) or wide resection of the ribs (thoracoplasty). A pulmonary collapse thus results blocking the excursions of the thoracic wall or, partial resection of the costal arches ensures [illegible] [illegible] [illegible] [illegible]

Step 1. Place the patient in ventral position with the head extending over the operating table and resting on [illegible] padded support. This is preceded by local anesthesia of the skin and muscles with novocaine [illegible].

Fig. 1271. Line of incision after [illegible].

Step 2. Make [illegible] longitudinal incision along the external margin of the long muscles of the spine. The incision must be made in such way that one-third of it is above and two-thirds below [illegible] horizontal line passing through the spinous process of the vertebra [illegible]. The lower end of the incision ends in an [illegible] horizontal line crossing the spine of the scapula (Fig. 1271). The skin, subcutaneous connective tissue and muscles are divided. The transverse processes of the vertebrae, the ribs and their intercostal muscles are well exposed.

Step 3. Regional infiltration anesthesia (novocaine) is now used around the posterior aspect of the transverse processes to be divided as well as in the immediate vicinity of the anterior and superior borders. On the anterior border of the 2nd, 3rd and 4th transverse processes we find [illegible] corresponding intercostal nerve. A good deal of attention should be paid to anesthetizing the first intercostal nerve running below the neck of the first rib as well as the intercostal spaces, particularly about the inferior margin of each rib.

Step 4. The operation being completed, the periosteum of the posterior surfaces, borders and the anterior surfaces of the transverse processes [illegible] removed by means of strong resection knife. By the aid of [illegible] chisel, the costotransverse process articulations at the posterior costal angle as well as the apophyses of the ribs are divided [illegible] [illegible] distance shown in the illustration. The neck of the rib is next completed. Costal resections must begin from below upward, from the fourth rib [illegible] the rib is thus exposed. The subperiosteal removal of the respec[illegible]

upward to the first rib inclusive. The rib is disarticulated from its attachment to the vertebra or, if preferred, divided near the articulation. About 8 to 10 cm. of rib is removed (Fig. [illegible] 72).

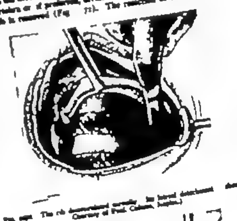


Fig. 1272. The rib disarticulated [illegible] [illegible] lateral detachment [illegible] shown. (Courtesy of Prof. Calerio, Naples.)

Fig. 1273. Resection of the first rib [illegible] Lebsche [illegible]. (Courtesy of Prof. Calerio, Naples.)

careful special attention. After having removed the lower ribs, the first rib presents itself with its posterior border and its inferior surface seemingly forming [illegible] roof over the field of operation. Subperiosteal resection must be performed with great care. The arteria-cervico-intercostal trunk that crosses

the neck of the rib must be guarded as well as the dome of the pleura. Externally we have the posterior scapular artery and still more externally and below, the cords of the brachial plexus and the subclavian artery and vein; these should be protected.

By displacing externally the field of operation and pushing the scapula laterally and forward we succeed in exposing the tubercle of Lisfranc. Resect about 12 cm. of the rib (Fig. [illegible]). The apex of the lung is now seen collapsed.

Step 5. The muscles and skin are now sutured leaving a drainage tube emerging at the inferior angle of the incision. The patient is returned to bed and placed in a reclining position and given 3 or 4 injections of camphor in oil daily and one injection of pantopon at night. The drainage tube is removed on the third day. Thus far the original operation of Frantz, Maurer and Rollaud has been described. This is rendered simpler by Calorio's modification, a description of which follows.

CALORIO'S MODIFICATION

Calorio has the patient sitting up in a high back chair turned around so that his arms and head may rest on the back of the chair. The advantage of this position is that the patient does not get too tired, respiratory embarrassment due to thoracic compression does not supervene and the operative procedure is facilitated.

CALORIO'S MODIFICATION

This refers to the resection of the costal arches. Instead of disarticulating the rib from its attachment to the spine and everting the rib laterally, Calorio prefers to excise the rib by dividing it into two segments—one short internal (vertebral) and one long external (scapular). The external fragment is resected first. This is grasped with a bone forceps and gradually everted back laterally. [illegible] subperiosteal resection proceeds, an assistant retracts the lateral margin of the scapula externally. It is then possible to proceed more laterally and to resect a great segment of the rib more easily. [illegible] too long, the short vertebral segment is taken care of later. Its removal is much easier because of the additional space now available and because the shortness of the segment allows greater ease of operative manipulation.

ARTIFICIAL PNEUMOTHORAX

The Concept of Selective Pneumothorax

Selective pneumothorax, according to the Italian school, was developed by Ascoli in 1912 [illegible] was Parry Morgan, according to the English and American schools, who in 1913 first pointed that in cases of incomplete collapse, the air tended to localize over and further collapse the diseased part of the lung.

The whole field of pneumothorax procedure was revolutionized by the proper concept of selective pneumothorax. Pneumothorax therapy was considered a specific invasive treatment capable of local application from which complete or nearly complete functional recovery might be anticipated. Incidentally the old type of compressive pneumothorax was like thoracoplasty.

Limitations of Selective Collapse. This treatment, according to theory [illegible] Chicago [illegible]

should be ideal. However, in practice its success is rather limited, due to the presence of adhesions, lesions, fibrous around cavities keeping them open, etc. Selective collapse should, therefore, be instituted early or not at all. It is indicated in localized lesions which do not reach the surface of the lung. In these cases the lesion is reduced to a small scar; hypertrophy and emphysema take care of any defects in the remaining lung tissue. Many early lesions treated in this manner are so completely cured that physical examination years later as well as x-ray reveals no scar or other evidence of pulmonary damage. On this basis pneumothorax is advocated early.

COMPRESSIVE PNEUMOTHORAX

Compressive pneumothorax consists in raising the intrapleural pressure above the zero level in the manometer, that is, above the atmospheric pressure. At the present time it is not applied to the entire lung. If it is definitely indicated, collapse should be brought about very gradually. The patient should be watched closely for any unfavorable symptoms. It may be necessary to add paraffin to oil, using it to induce mechanical fixation during the course of this treatment.

BILATERAL PNEUMOTHORAX

There are two methods for applying bilateral pneumothorax. The method most commonly used is really an alternating pneumothorax and not really a bilateral pneumothorax. The lung most affected is treated first; when sufficient improvement is manifest, collapse may be reduced or withdrawn entirely and the other lung treated. If alternating collapse is resorted to, its type may be compressive, partial, selective, etc.

Partial collapse is never resorted to on both sides at once, but at different times, allowing a fairly long period between the treatment of one side and that of the other. Refills are also done at different times.

Contralateral collapse is never resorted to while there is complete collapse on one side except in extreme emergency as a pleuro-pulmonary perforation is likely to result on the other side.

CONTRALATERAL PNEUMOTHORAX

Contralateral pneumothorax is used on rare occasions in cases of inducing pneumothorax on the healthy side to cure a lesion on the opposite side. A flexible mediastinum is essential for its effectiveness, since if there is a change in pressure in one pleural cavity there will also occur changed pressure conditions in the other. A partial mediastinal displacement causing a reduction in the negative pressure on the better side, results in a corresponding reduction in pressure on the affected side. In this way it is possible to accomplish a partial collapse in the affected lung which may aid lesion repair.

Duration of Treatment. The duration of the treatment depends upon the extension of the lesion, the evolution or activity, the social condition of the patient, the occupation, the availability of refill facilities, etc. If the case has not progressed too far, a collapse of from 6 to 9 months to a year may be sufficient. If the case is well advanced, it should be maintained much longer. Dr. Frederick Tice believes that the early case with slight activity may be allowed to re-expand under given circumstances, in a period of six or seven months to a year, with good prospects of healing and even complete return to normal. This is particularly true

of the patient in good social circumstances, who can afford to lead a sheltered and careful existence. Usually a collapse period of from two to five years is advocated. There are some cases in which pneumothorax has been maintained for a period of ten to fifteen years. This, however, is not advisable, because thoracoplasty should be resorted to in cases not yielding to pneumothorax. As a general proposition it may be stated that in any except an early case from six months to a year should be required to induce collapse which should be maintained from one to two years. Re-expansion should cover a period of from six months to a year. If after conducting the treatment aided by supplementary measures over a period of six months, no improvement is noted, it should be discontinued.

The Technic of Re-expansion

This procedure requires considerable knowledge and skill. It should be carried out as carefully and painstakingly as collapse.

A diseased lung heals at the expense of considerable lung tissue resulting in loss of this structure which corresponds to the extent of the lesion and deposit of fibrosis. Obviously it can never expand to fill the hemithorax, nor should it be permitted to expand its limit. The fixed mediastinum will not permit enough mediastinal displacement to assist in filling the defect.

It may be necessary in some cases to reduce the size of the hemithorax by means of phrenicectomy. In some instances hypertrophy may be depended upon to fill the hemithorax; if this seems likely watchful waiting is justified. The surgeon should watch carefully for any evidence of reactivation owing to the partially healed lesion opening, which should be an indication for phrenicectomy or thoracoplasty.

In severe cases some surgeons contend the re-expansion period should cover one year. The amount of pneumothorax is gradually reduced during this time and the interval between injections is gradually lengthened. If it seems necessary to reduce the pneumothorax immediately, the surgeon should be able to decide whether the danger from collapse as indicated by activity in the contralateral lung is as great as the danger from rapid expansion.

Rationale of Pneumothorax

The successful use of artificial pneumothorax depends upon the absence of adhesions in the pleural space though a few minor adhesions do not form a counter-indication to its use. If the visceral and parietal pleurae in tuberculosis are not extensively adherent, the affected lung may be temporarily collapsed and put at rest by filling the pleural cavity with some non-irritating gas which resists too rapid absorption. Forlanini belongs the credit of having first suggested this procedure in 1882. His work was forgotten, to be independently taken up at later date by Forlanini in 1894 and later by Murphy. Nitrogen gas was used by these observers. Brauer was an enthusiastic advocate of the method.

Definition. Introduction of air or gas by artificial means into the pleural cavity.

Object.

To collapse and promote healing of cavities.

To close cavities and infiltrates by partial collapse; produce rest and relaxation and thereby promote absorption and prevent spreading.

3. To control pulmonary hemorrhage.
4. As a public health measure to convert positive sputum cases to negative and thereby prevent spreading of the disease.

Indications for Collapse Therapy

MOST IMPORTANT INDICATIONS

A unilateral lesion of greater than minimal extent, especially in the presence of cavitation and positive sputum.

A bilateral lesion of greater than minimal extent where the good side is relatively inactive or quiescent.

3. Early lesions and infiltrates, especially when the x-ray reveals cavitation. Sputum early or may not be positive.

Public Health Indications.

LIFE SAVING INDICATIONS

Uncontrollable hemorrhage.

Repeated small hemorrhages.

3. Spontaneous pneumothorax.

UNUSUAL INDICATIONS

Diagnostic pneumothorax.

Pleurisy with effusion.

Bronchiectasis.

Lung abscess especially with hemorrhage.

SELECTION OF CANDIDATES

Unilateral, Incipient or Moderately Advanced. A unilateral exudative upper lobe lesion of greater than minimal extent, of short duration, sputum positive, with demonstrable cavitation by stereo-x-ray, temperature below 100° F. is the ideal type of case for pneumothorax treatment. Early pneumothorax before any destruction has been done, before softening of infiltration takes place with consequent cavity formation.

Unilateral, Advanced Cases. Cases of similar type where x-ray reveals more extensive cavitation, and the patient gives a history of hemorrhage, usually are successful and a good collapse is obtained.

Bilateral Cases. The same may be said of bilateral cases of short duration where collapse may be done simultaneously. Satisfactory collapse and excellent results are usually obtained. The more actively involved lung should be collapsed first and when a satisfactory selective collapse is obtained, collapse of the contralateral lung is started.

For Advanced Chronic Cases. Cases of longer duration, far advanced, where x-ray reveals unilateral and active multiple cavities, pneumothorax should be tried even though the contralateral better lung shows some involvement with chronic fibrosis. Good collapse may be obtained and the patient will do well.

For Advanced Disease with Pneumothorax on Contralateral Better Lung. Pneumothorax on the contralateral better lung, to prepare for further radical surgery on the more extensively involved side has been done in a series of far advanced cases and excellent results obtained. By collapsing the one side for a period of one to two years, definite beneficial effects are often seen on the contralateral bad lung, though it has to carry the burden of respiration for

time that the better lung is collapsed. Complete healing of small cavities and clearing of exudates in the re-expanded lung are seen and radical surgery may be done on the more advanced lung.

For Advanced Bilateral Lower Lobe Lesions. In order to collapse a lesion or basal cavity where the wall is thickened and hard, the entire lung must be collapsed for a longer period of time, and therefore bilateral pneumothorax is not possible, at least not simultaneously. However, we do see lower lobe selective collapse and in such cases bilateral collapse may be successfully carried out.

Refills Following Spontaneous Pneumothorax. If tuberculosis is known to be present in the spontaneously collapsed lung, the patient is given the same routine as in artificial pneumothorax. However, where spontaneous collapse occurs in tuberculous people in far advanced cases only a partial collapse can be obtained, for there are usually numerous adhesions, and if the collapse is due to an injury to the lung, such as tearing of an adhesion as is often the cause of the accident, pleural exudate and empyema are likely to follow and, depending on the condition of the patient, more radical surgery is then the proper treatment.

Spontaneous collapse of a lung where no tuberculosis is known to exist and where tuberculosis cannot be demonstrated, occurs. If the patient is in shock or very dyspneic, the pressure should be removed by inserting the pneumothorax needle and withdrawing air until the patient is comfortable. This may be repeated, in the course of a few weeks if no complications set in. This gives the lung a better chance to re-expand slowly.

Diagnostic Pneumothorax

This may be done to differentiate annular shadows, which may not be excavations, from cavities, and for differential diagnosis in cases where malignancy is suspected.

To determine whether any disease actually exists in a certain part of a lung, selective collapse proves that the lung has lost its expansibility and is diseased.

IN PLEURISY WITH EFFUSION

When fluid is withdrawn it may be partly replaced by air. This, when repeated, gives the lung a better chance to re-expand slowly for study in order to determine if the condition of the lung is such that pneumothorax is indicated.

IN BRONCHIECTASIS

This has been done, but very little, if any, beneficial effect has ever been found and we do not recommend it.

IN LUNG ABSCESS

This treatment has been attempted but few beneficial results obtained.

If the abscess is open and draining by way of the bronchi it may be possible to obtain some collapse but a better result is obtained by more radical procedures such as surgical drainage and thoracoplasty.

Preparation of Patient

No special preparation is necessary. The patient should be assured that there is no pain and little if any danger in the operation. Pneumothorax should not be done immediately after a full meal.

The patient is placed on the table, stripped to the waist, lying on the better

side (i.e., with the side of the chest to be collapsed up), the foot end of the table *elevated*, the patient with both arms stretched upward over the head, a pad or pillow under the chest, not under the shoulder but below the shoulder, and the head down.

The site of operation depends on the type and location of the pathologic process in the diseased lung. The needle should be inserted over the part of the lung which shows the least evidence of pathologic changes and never over an area showing an exudative process, over a cavity nor over an area showing thickened pleura, for we are more likely to encounter adhesions over the diseased part and here there is more danger of entering the lung. The fifth to seventh intercostal space in the posterior or midaxillary line is usually the favorable site to insert the needle.

Anesthesia. The skin and deep tissues are injected by a one-inch, [illegible] gauge hypodermic needle using ½ to [illegible] per cent novocaine. This will reach the parietal pleura in most cases. If not, a longer needle should be used. It is important to anesthetize the parietal pleura when a blunt needle is used to induce the pneumothorax to avoid pleural shock. The skin and superficial tissues are now punctured with a sharp instrument, as a bistoury knife or sharp needle of the same size, to prepare for the insertion of the blunt needle.

Fig. [illegible]. Types of needle. [illegible] The type of needle should not be [illegible] [illegible] [illegible] [illegible] of pneumothorax [illegible] used in [illegible] (Courtesy of Dr. Allen [illegible] and Dr. E. J. [illegible])

Initial Injection

NEEDLE USED

This is an ordinary two-inch, 18-gauge needle. The sharp point has been taken off, the opening at the point closed and a slit 4 mm. long made on the side. The needle is blunt and if the lung is free there is no danger of puncturing the visceral pleura, and injuring the lung (Fig. 1174).

To determine when the needle has penetrated the parietal pleura and entered the thoracic cavity remember that there is no air or gas in the thoracic cavity and consequently no air can be drawn back into the syringe. There is a vacuum and suction, when the syringe is removed from the needle. If the needle is filled with some of the fluid from the syringe, this will be seen to disappear into the thoracic cavity if the parietal pleura has been punctured.

On connecting the manometer, free fluctuations will usually be found. A small amount of air is then allowed to pass into the thorax under frequent manometric readings, until the desired amount is given. If the needle strikes an adhesion or thickened pleura and no free space can be found, a trial must be made again at some other place, this to be repeated until one has been successful or is satisfied that there is no free space.

If the needle has been inserted too deep into the adherent lung and entered the lung tissue, air and often blood will be drawn back into the syringe, the manometer may show fluctuation, and it will be noticed that if the patient holds

his breath in deep inspiration the manometer will show a negative pressure of 6-7 mm. Hg but this will drop slowly even when the patient is not breathing. On the contrary, if the needle has entered the pleural space and not the lung, the negative pressure as shown by the manometer will remain at the same point on deep inspiration. In cases where phrenicotomy has been done or where there may be a rise of the diaphragm for other reasons, care must be taken not to insert the needle below the diaphragm. Pneumoperitoneum is not good treatment in pulmonary tuberculosis. If the needle has entered the peritoneal or abdominal cavity, the manometer will show positive pressure on inspiration and vice versa in contrast to the intrathoracic pressure which is negative on inspiration. These points are of importance and should be carefully observed before any air is allowed to flow into the chest cavity.

If the needle has punctured the lung, the patient will usually start coughing and it will be seen that blood and air or a slightly blood-tinged froth can be drawn back into the syringe. The needle must be immediately withdrawn and no air allowed to enter. If air enters the pulmonary circulation, embolism is likely to result.

AMOUNT OF AIR TO BE GIVEN

No air must ever be given unless there is free fluctuation and a negative manometer reading remaining at the same point when the patient holds his breath in deep inspiration.

How much air should be given at the initial treatment? This depends on the type and extent of the lung lesion, and the reading of the manometer. Positive pressure should never be reached, but a free fluctuation from about [illegible] or 3 to 4 or 5 minus.

This is usually obtained after giving 2-300 cc. of air. The first refill is given within 24 hours and about the same amount of air is given. The intervals are slowly lengthened from one to two, three and four days until weekly intervals are reached. Then the patient is kept on weekly intervals for several weeks. This, however, depends upon the condition of the patient, and on the type and extent of the involvement of the diseased lung.

When pneumothorax has been established and a satisfactory collapse obtained, the symptoms subside, the sputum becomes negative, and the patient gains in weight, the intervals may be lengthened from ten days to two weeks and later to three or four weeks or more, depending on what the collapsed lung will do, whether it remains in a state of collapse or has a tendency to re-expand. This must be carefully observed by fluoroscope or x-ray.

If the lung shows a tendency to re-expand on longer intervals between refills, more frequent refills must be given, since the lung must not be allowed to re-expand to the point where it touches the chest wall. *Pleural adhesions are very likely to form and cause a successful case to be a failure.*

COMPLICATIONS IN PNEUMOTHORAX

1. Air Embolism
2. Pleural Shock
3. Interpleural adhesions
4. Pleural Exudate
5. Spontaneous Pneumothorax.

6. Empyema.
7. Emphysema.
8. Skin or Superficial Infection.

Air embolism may occur following puncture of the lung whether air has been permitted to enter or not. If the pulmonary tissue has been punctured, air from the lung may be sucked or drawn from the alveoli or bronchioles into the venous circulation, whence it goes to the left ventricle of the heart and then to the general circulation. The symptoms depend on what part of the brain is affected.

Death may occur almost instantly or within a few minutes.

Pleural shock has been discussed by various authorities, some assert that it does occur, others that it does not and that all so-called pleural shock cases are air embolism. No doubt some cases of shock in pneumothorax are embolism. However, we have seen cases going into shock on refills where the compressed lung could not possibly be reached by the needle, and also cases where shock occurred before the parietal pleura had been penetrated. The symptom is that of syncope which may last from a few to 10 or 15 minutes; the patient recovers suffering from no after effect. In embolism, on the contrary, if the patient recovers, there are some after effects such as partial paralysis of arm or leg or disturbed vision of one or both eyes, lasting for some time.

Interpleural adhesions are encountered in a number of cases, usually in those of long duration and in cases giving a history of chronic pleurisy.

They may involve an entire lobe or more and it may be only a few thin stringlike bands. They may not interfere in obtaining a satisfactory collapse and yet one or two tiny bands may prevent the collapse of cavities (hanging cavities) or an important part of the lung so that it becomes necessary to cut these adhesions.

Pleural Exudate. In cases where a satisfactory collapse has been obtained and a small amount of pleural exudate develops, it may be found by fluoroscopy or x-ray. These small amounts are usually absorbed and do no harm. If the fluid increases and persists to a point where it becomes annoying to the patient it is removed gradually. It is nearly always clear, straw colored and sterile, although acid fast bacilli may be found in cultures. Great care must be used to prevent carrying infection into this fluid. If it becomes infected, whether from within or without, we have one of our most serious complications in pneumothorax, empyema. The intrathoracic pressure is usually increased when an exudate develops, and it may even be necessary to remove fluid without doing any inflation with air. It seems that high intrathoracic pressure has a tendency to invite the formation of exudate and therefore the intrathoracic pressure should never be raised equal to the atmospheric pressure, only in rare cases when there is some definite indication such as a need to collapse a persistent thick walled cavity or to stretch a string of adhesions.

Sanguineous exudate or hemothorax is rarely found in pneumothorax. If it is found, unless it can be accounted for by puncturing the lung, intercostal blood vessels or tearing of adhesions, or malignancy should be suspected.

Spontaneous Pneumothorax. This occurs, not infrequently in pneumothorax treatment, usually early and most commonly is caused by puncturing the lung at the initial injection or at some later refill, where the lung is close to the

chest wall, not actually adherent, yet sticking to the parietal pleura so much that a sharp pointed needle will penetrate the visceral with the parietal pleura and therefore a blunt needle should be used, as stated in the article on technic, until the lung is entirely free and separated from the chest wall. The use of this needle will prevent such an accident unless we strike into an adhesion and puncture the lung that way.

Tearing of a small adhesion or rupture of a small bleb or bulla, which may form under the visceral pleura, is another cause of spontaneous pneumothorax. The exact cause in any case can hardly ever be determined, as the patient nearly always recovers.

Treatment of spontaneous pneumothorax where artificial collapse has been started in unilateral cases consists in keeping the intrathoracic pressure down to a point where the patient is comfortable; this is done by inserting the pneumothorax needle and drawing out air until the desired pressure is reached, repeating when necessary and keeping under close observation by x-ray and fluoroscopy.

In cases where there is a large tear and a valvelike action which permits the air from the lung to enter the pleural cavity but by closing prevents its escape and the chest fills up rapidly when the patient becomes dyspneic in a short time, a needle should be inserted connected to a rubber tube leading into a water bottle placed under the bed. The needle and tube are then strapped to the patient's chest by adhesive tape and to the frame of the bed so that the tube reaches down into the water for about an inch; this permits the air to escape through the tube when the intra-thoracic pressure reaches a certain point. Air bubbles will be seen coming out through the water but no air can re-enter (Fig. 777).

In bilateral cases particularly this treatment has proven of great value. It is simple and can be carried out in the patient's room without any disturbance to the patient.

A puncture or small tear in the visceral pleura will heal in a short time and rarely do complications develop.

Empyema. Next to air embolism, empyema is the most serious complication in artificial pneumothorax, and goes hand in hand with or follows the simple pleural exudate or spontaneous pneumothorax. However the number of cases developing empyema is very small.

When a patient under pneumothorax treatment develops a pleural exudate, that is a clear straw colored slightly greenish fluid, which is sterile, although tubercle bacilli may be demonstrated but no other organism can be found. If this exudate is not absorbed but increases and becomes infected, whether it is from within or from without, empyema is the result. The endogenous infection or infection from within no doubt is the more common. Infection from without can occur if a strict sterile technic is not used at all times.

Treatment of Empyema. The closed method of drainage and irrigation may be done but this nearly always results in a fistula and secondary infection, the condition becomes more serious while nothing has been accomplished. The case will go on to radical surgery. This must be done while the patient's condition is such that he can be considered a good risk and before amyloidosis of other organs such as the liver and kidney develops and the condition becomes hopeless.

Subcutaneous Emphysema. This condition occurs, but is rarely seen when

small needle is used in refills. If an 18 gauge needle is used the small puncture to the pleura does not permit any air to escape into the tissues outside the chest wall.

Treatment. A small area of emphysema needs no treatment. If a large part of the thorax and neck becomes involved tight strapping will prevent spreading and absorption takes place. Serious complications are rarely encountered.

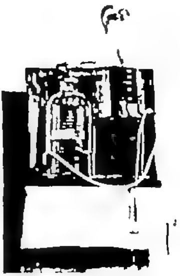


Fig. 777. Pneumothorax apparatus used at the Municipal Tuberculosis Sanitarium of Chicago.

Skin Infection. It is not uncommon to find skin infections as acne or pustules. Such conditions are often overlooked and disregarded, however care must be used not to select such an area for inserting the pneumothorax needle. Infection can easily be carried into the pleural cavity and result in empyema.

CONTRAINDICATIONS

1. Uncontrollable activity on the opposite side.
   Unusually large cavities.
3. Patients over 50 years of age.
4. Extreme emaciation.
5. Cardiac decompensation or myocarditis.
6. Marked diminution in vital capacity.

SUITABLE CASES	UNSUITABLE CASES
Unilateral lesions	Bilateral lesions
Thin walled cavities	Thick walled cavities
3 Cavities of moderate size	3 Unusually large cavities
Absence of serious tuberculous complications	Presence of serious tuberculous complications
5 Absence of adhesions	5 Presence of adhesions or thickened pleura
6 Inactivity of the process on the good side	6 Activity of the process on the good side
7 Young adults under 40	7 Elderly patients over 45 or 50
8 Maintenance of vital capacity	8 Marked diminution of vital capacity
Normal heart function	9 Organic heart disease
10 Good nutrition	10 Extreme emaciation
Recent cases	Aborigional cases
Low grade or no fever	12 High fever
13 Absence of other lung pathology	Presence of asthma, emphysema or silicosis
14 Some tendency to healing	14 Very acute processes or pneumonic lesions

Uncontrollable Activity on the Opposite Side. Bilateral extensive exudative disease where half or more of each lung shows involvement, temperature over 101° F. rapid pulse and rapid loss of weight.

Bilateral cases where an entire lung is involved with an active exudative process with high temperature should not be treated until the acute symptoms subside.

The foregoing material is quoted and is the routine method of procedure at the Municipal Tuberculosis Sanitarium of Chicago. Direction of Drs. Allen J. Hruby and E. J. Stranchers.

Comment. Under "New Portable Pneumothorax Machine,"* Dr. J. J. Singer, St. Louis, describes this apparatus on which he comments as follows (Fig. 778):

"This machine is presented because it embodies many desirable features which will be enumerated.

"It is made almost entirely of metal sufficiently heavy to withstand accidental tipping or breakage. The transparencies are made of heavy break-resisting glass and the gauge is made of hard glass. The apparatus consists essentially of two chambers, an upper and a lower. The new type manometer consists of a bellows, enclosed in a metal case, which opens and closes with the variations of the air pressure within. The needle on the dial shows these variations of pressure in cubic centimeters of water. It is mounted on fine jeweled bearings. Air can be put into or withdrawn from the chest through the manometer valve in the center of the instrument. Pleural pressure readings may also be obtained by changing the handle of this valve. We use 1000 cc. of mineral oil instead of water as

* Journal of Thoracic Surgery, June, 1931, Vol. [illegible] No. [illegible] pp. [illegible]

this does not corrode any of the metal parts. Tubing to which is attached a needle with a valve is inserted into the uppermost opening, and with the manometer valve placed in the proper position it is ready for use in pneumothorax work or aspirating air from the chest. A small test tube

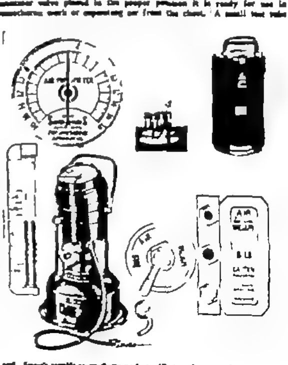


Fig. 778. Singer's portable pneumothorax machine. (Graham, Singer and Ballon. Surgical Diseases of the Chest, Lea & Febiger.)

rack may be attached to a clip on the back of the machine which is not visible in the photograph. The apparatus as illustrated weighs ten pounds.

OLEOTHORAX

This was first described and performed by Bernou in 1921.

Indications for oleothorax: (a) compression, (b) prevention of adhesions (antisymphyseal), and (c) antiseptic.

Children tolerate this procedure well. It may be combined with pneumothorax where there is a tendency to adhesions between the pleural layers. It is useful as a treatment for pleurisy, particularly recurrent tuberculous pleurisies which do not readily respond to other treatment, tuberculous empyema, and secondarily infected non-tuberculous pleurisies. It is quite effective in treating small perforations which result from tearing the adhesions but if the perforations are large it is better to use oleothorax preparatory to doing thoracoplasty. It is also useful in the valvular type of perforation where there is an effusion and in cases where more pressure is indicated over a part of the lung than can be obtained by pneumothorax.

In some instances oleothorax has been substituted for pneumothorax as a matter of convenience. A thicker tougher pleura results from its use. It should be used only under trained supervision. In many instances it is more effective and constant in its accomplishments than pneumothorax. It furnishes a means of applying antiseptics directly to the pleural surface and of replacing septic fluid with antiseptic oil. Liquid paraffin and olive oil are the oils generally used. Olive oil is more widely used and is more soothing and readily absorbed than liquid paraffin which is easier to prepare but has a tendency to produce pleural intolerance. The latter is indicated where a more or less permanent collapse is desired with few refills. Oils used must be absolutely pure, neutralized and sterilized at a high temperature. The antiseptic is added after the oil is sterilized. It is convenient to pour the oil into 100- to 250-cc. glass ampoules which are placed in a warm water so that the oil is at body temperature at the time of injection and connected to the tubing of the injection apparatus.

Gomenol is the antiseptic of choice—2 to 5 per cent, usually [illegible] per cent.

Oleothorax is often a more difficult and complicated procedure than pneumothorax for the following reasons:

1. In comparison with air the oil is non-compressible; decided changes in pressure result from the increase or decrease of a few cubic centimeters.
2. Because of the viscosity of the oil, as compared with air, no accurate device is available for ascertaining the intrapleural pressure.
3. Some pleurae are highly sensitive to oil resulting in frequent effusions which may prove serious due to the increase in pressure.

Patients in whom oleothorax has been done should be observed for sudden high temperatures, evidence of perforation, oil in the sputum or in the vomitus.

The chief obstacle with which the manufacturer of an oleothorax machine is concerned is the viscosity of the oil which necessitates a great deal of pressure to force it through the needle so that it is impossible to directly determine the oil pressure within the pleura. Instead a manometer is used for this purpose.

Where this treatment is used in place of pneumothorax, or to substitute for the fluid of an effusion or empyema, the apparatus must be able to displace accurately the amount of air and fluid with oil.

The patient is prepared the same as for pneumothorax. Not more than 10 cc. of oil should be given at the first treatment and the patient watched for several days following for signs of pleural sensitivity. A number of injections are sometimes required to produce an oleothorax of 100 to 200 cc. Sometimes effusions are replaced first by air and later by oil.

In treating empyema large amounts of oil are injected at one time. The pleural cavity may be washed out with saline solution first. The oil must be changed often in these cases. Oil which is not infected will remain fresh for an indefinite period in the pleural cavity.

FAT IMPLANTATION AND PLOMBAGE

Filling the space between the parietal pleura and the chest wall may be accomplished by the transplantation of fat from the patient's own fat layer from the abdomen or buttocks (Tuffier). Plombage of cavities in the upper lobe is a method of expediency which is only to be considered where a thoracoplasty is fraught with danger to the patient as in cases of advanced age or marked emphysema or in threatened hemorrhage from cavities; provided, however, that pneumothorax cannot be done (Alberts).

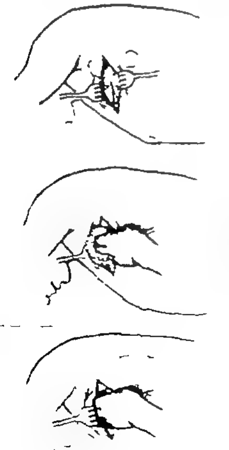
Illustrated Technic of Fat Implantation

Approach the apex either from the anterior axillary region or from behind by the route taken to reach the posterior portion of the superior mediastinum.

When operating from behind one finds it comparatively easy to push the parietal pleura away from the chest wall. In operating from the front or in the axilla, it is seldom necessary to resect more than one rib because the intercostal spaces in front are much wider than those in the back. In the approach through the anterior region make an incision over the second rib from the midaxillary line forward for about six inches. Remove subperiosteally about four inches of the rib. Separate the tissues between the endothoracic fascia and the chest wall very carefully beginning from behind with the fingers, holding their dorsal surfaces close to the chest wall. The fingers gradually creep upward toward the apex, making as little pressure as possible upon the pleura, separating the pleura from the thoracic wall. The fingers reach the dome of the pleura which may lie above the first rib, or in old fibrotic cases, the pleura may have been drawn downward to a plane lower than the first rib. Tuffier refers to the "ligament of the summit of the pleura" described by Sebileau, which is a fibrous band attached to the anterior part of the seventh cervical vertebra. It may require a little additional force to loosen this band and the manipulation must be carried out with very great care lest the pleura be torn.

When the parietal and visceral layers are adhering this maneuver will be easier but there again is the added danger of entering a tuberculous cavity. Having reached the dome of the pleura, pressure is made downward with the fingers (Fig. 1277). Separate the posterior portion of the pleura from the chest wall. A vacant space results. Fat from the abdomen or buttocks removed simultaneously by an assistant should be immediately crowded into the cavity which must be filled completely (Fig. 1278).

Draw the intercostal structures toward each other with a few chromicized catgut sutures. The skin and overlying muscles are approximated over all (Fig. 1279). If the operation has been carried out without accident or infection primary union will follow. If there has been an accidental perforation into a pulmonary cavity with or without hemorrhage the opening into the lung should at once be enlarged with the fingers, and after cleansing the interior it should be



packed with gauze, preferably vioformed, or with rubber dam, and most of the wound left open.

PHRENIC NERVE AVULSION

Phrenic Nerve Crushing, Phrenicotomy, Phrenic Exeresis, Phrenic Neurectomy

Anatomic Points. The phrenic nerve is formed by branches from the third, fourth, and fifth cervical nerves. It crosses the scalenus anticus muscle, goes behind the suprascapular and transversalis colli vessels, then over the subclavian artery and behind the subclavian vein. After passing in front of the internal mammary artery it enters the superior mediastinum of the thorax. From here the nerve traverses the middle mediastinum, lying between the pericardium and the pleura and pierces the diaphragm. It breaks up on its under surface and has the following

Communications. The loop between the first and second gives off a branch to (a) the vagus, (b) the hypoglossal, and (c) the superior cervical ganglion of the sympathetic. The second and third send a branch to the descendens hypoglossi to form the ansa hypoglossi. The second, third, and fourth communicate with (a) the spinal accessory and (b) the superior cervical ganglion of the sympathetic.

While the operation has been performed by some surgeons on both sides for the relief of bilateral bronchiectasis, Rienhoff reports a case operated on by someone else where the patient died from respiratory failure, as a result of bilateral intervention.

Temporary or permanent interruption of the phrenic nerve may be obtained. In the former case simple crushing of the nerve with a hemostatic forceps is resorted to or a few drops of absolute alcohol is injected into the nerve. Following crushing or injection, the nerve regenerates and the function of the diaphragm returns in from about three to six months.

Step 1. **Position of Patient.** The patient lies flat on his back with a pillow or sandbag beneath the shoulders; the head is turned opposite to the side to be operated upon. Drape the head in an earpiece cap. Prepare the skin of the neck in the usual manner (iodine—alcohol—picric acid, etc.).

Anesthesia and Incision (Fig. 1280). Local infiltration anesthesia with 1 per cent novocain injected into the skin in a line just behind the border of the sternocleidomastoid muscle beginning at about the level of the top of the thyroid cartilage and extending downward to the upper border of the clavicle.

Step 2. After the skin incision has been made, the deeper parts are infiltrated. Infiltration should be thorough and no pain should be complained of by the patient. Precede the injection of the anesthetic with the subcutaneous administration of morphine gr. 1/4 with atropine sulphate [illegible] gr. Nitrous oxide-oxygen anesthesia may also be used. In that event, however, the advantage of the pain as a guide that the phrenic nerve has been isolated is lost.

An incision about one or two inches in length is made parallel to the clavicle (Fig. 1280[illegible]). It is deepened, exposing the posterior border of the sternocleidomastoid muscle. The external jugular vein may be avoided but if the neck is short it is best to promptly clamp, ligate, and divide the vessel. Dissect the tissues carefully down.

Step 3. Retract the jugular vein, the location of which can be easily ascertained by its relation to the carotid, the pulsation of which should be felt.

Scalenus medius.
3. Scalenus posterior.

SCALENIOTOMY

SURGICAL TREATMENT OF BRONCHIECTASIS

Pneumothorax and Pneumolysis.
Pulmonary Decortication.
Ligation of the Pulmonary Artery (Sauerbruch).
3. Resection of the Affected Lobe.
Graham's Cautery Operation.

TUMORS OF THE LUNG

Metastatic.
Contiguous affection.
3. Primary.

ECHINOCOCCUS

DERMOID TUMORS

Step [illegible] The manubrium sterni as well as the lower portion of the gladiolus sterni opposite the sixth interspace is trephined with a Doyen burr.
Step 3. The mediastinal contents are dissected away from the back of the sternum and a Gigli guide passed from one trephine hole to the other.

F[illegible] Kerr and [illegible] method of thoracotomy [illegible] of the [illegible] first and sixth interspaces [illegible] left half of the sternum [illegible] This thoracotomy [illegible] perfect [illegible] of the lung

Step 4. The saw is passed and the sternum split longitudinally bending the saw-cut sharply to the right. The two trephine openings are then connected to the first and sixth left interspaces with a DeVilbiss bone-cutting forceps.
Step 5. The skin and intercostal muscles of the first and sixth interspaces are cut midway between the ribs. On elevating the flap the reflection of the pleura from the mediastinum to the anterior chest wall is exposed and divided. The trapdoor can then be sprung open exposing the entire left hemi-

thoracic cavity. The tumor can be seen presenting behind the pleura (Fig. [illegible]).
Step 6. *The anterior mammary vessels are found, ligated and divided.*
Step 7. The pleura is stripped from the tumor and the cyst is dissected with the finger and shelled out.
Step 8. The pedicle where the vessels supply the tumor is clamped and divided.
Step 9. The debris is sponged out of the pleural cavity and the lung expanded by increasing the oxygen pressure to [illegible] mg. of mercury.
Step 10. The osteoplastic trapdoor is closed and held in place by two kangaroo sutures passed around the sternum through the second and fifth interspaces. A No. [illegible] chromic suture is passed around the sixth and seventh ribs close to the sternum and another around the second and through a drill hole in the first rib. This effectually holds the localized [illegible] of the sternum closed.
Step 11. The superficial fascia is closed with a continuous locked suture of No. [illegible] plain catgut. The skin is sutured with silkworm gut. Dressings are strapped to the left chest with adhesive plaster.

LOBECTOMY

This signifies the removal of a diseased segment or lobe of a lung. The knife or electrocautery may be used. Bleeding is controlled by compression of smaller vessels and ligation of larger ones. Open bronchial ends may lead to bronchial fistulae. Their mucous membrane should be removed for a [illegible] cm. and the ends securely closed by ligature. Large elastic Doyen clamps (Fig. [illegible]) serve well for temporary hemostasis and are applied on either side of the section of the lung to be removed. Where the resection is undertaken at the hilus, [illegible] advises the application of a temporary elastic constrictor. After ablation of the diseased segment, the stump of lung is sutured, preferably in sections (Garre). Where suture is not possible, tamponade should be resorted to.

In the hands of the experienced, lobectomy should have a mortality nowadays of from [illegible] to [illegible] per cent (Nissen). (Fig. [illegible])

Amputation of a Lobe of the Lung

The underlying principles of this operation are:

Step 1. *Isolate and ligate the large blood vessels at the hilus of the lung* separately (Friedrich) without including the bronchi, because if this precaution be neglected the bronchi supplied by the ligated blood vessels would suffer. Where needed speed or inflammatory conditions prohibit to proceed as outlined, a rubber tube may be made to temporarily encircle the vessels and main bronchus due to compression produced in embolectomy of the pulmonary artery ([illegible]).
Step 2. Division of the main bronchus supplying the respective lobe must be accomplished at some distance from the reflection of the pleura. In other words, the lobe of the lung must be resected in such a manner that the entire stem of the bronchus running through the lobe is removed. If this precaution is neglected mediastinal infection or emphysema may result from the retraction of the bronchus.
Step 3. Closure of the bronchus. Curet the mucous membrane of the bronchus

for a little distance. Ligate it beyond this area and reinforce it by another catgut ligature beyond the first one.
Step 4. Use tamponade from the operated region on to the surface of the wound.

Willy Meyer counseled: (a) Crushing of the bronchus and ligating it. (b) *Inversion like an appendix stump.* (c) *Covering the inverted bronchial stump* with interrupted catgut sutures. (Fig. [illegible])

[illegible] Nissen belongs the credit of having successfully done the first pneumonectomy for bronchiectasis in [illegible]. The operation is indicated in unilateral *bronchiectasis* (Fig. [illegible]). It is a major procedure demanding meticulous technic and painstaking preoperative as well as postoperative care. Infection of the pleural cavity should be guarded against. Mediastinal emphysema, suppurations and leakage from the stump are often inimical to success. The single

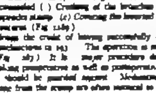


Fig. [illegible] Application of lung clamps in partial resection of a lung. (After [illegible] and [illegible])

stage operation is apparently the simplest and consists of opening the chest, liberating the affected lobe and amputating it at the hilum. Multiple-stage operations are preferred by many.

Preliminary pneumothorax to ascertain the extent of pleural adhesions and to reduce shock when the chest is opened is counseled by some.

Anesthesia. Preliminary basal narcosis supplemented by overpressure inhalation is the anesthetic of choice.

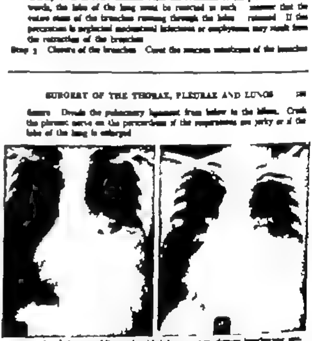
One-Stage Operation

Step [illegible] Place the patient on the unaffected side with a firm pillow under the axilla arching the side to be operated upon. Deflect the head of the patient a little downward thus permitting secretions to be aspirated with a suction apparatus.
Step 2. Make a long incision along the line of the 6th or 7th interspace along the course of the rib (Fig. [illegible]). Attend to hemostasis. Open the chest in the exposed interspace for about ten inches. While dividing the pleura the lung slowly collapses. Enhance exposure by properly constructed rib spreaders. If deemed advisable, a portion of one or more ribs at their posterior end may be removed. (Fig. [illegible])

With scissors separate any existing adhesions between the parietal and surface of the affected lung. Effect separation along the interlobar

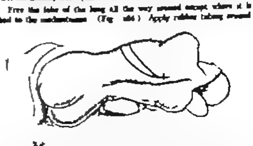
[illegible]

fissure. Divide the pulmonary ligament from below to the hilum. Crush the phrenic nerve on the pericardium if the suppuration are [illegible] or if the lobe of the lung is enlarged.



[illegible] Left x-ray following lipiodol before operation, showing bronchiectasis [illegible] Right x-ray after operation. Lower lobe and [illegible] and ninth ribs removed. [illegible] aged [illegible] [illegible] bronchiectasis [illegible] [illegible] Recovery was uneventful. [illegible] symptom free and clinically well. (Case of Dr. Richard Lewisohn.)

Step 4. Free the lobe of the lung all the way around except where it is attached to the mediastinum. (Fig. [illegible]) Apply rubber tubing around the



[illegible] Position of patient on the table for [illegible] and [illegible] [illegible] (After Howard Lilienthal.)

hilum or use crushing clamp to occlude the blood vessels coursing to the *lobe of the lung.* (Fig. [illegible])
Step 5. Amputate the lung by a wedge-shaped incision in such a manner that the raw borders of the lung tissue may be sutured over the stump. Secure

the blood supply by means of several mattress sutures through the stump. Crush and excise the protruding ends of bronchi. (Figs. [illegible].)

Step 8. Remove the clamp and inspect the stump for bleeding points. Secure the stump to the adjacent lobe of the lung. To completely remove the lobe, apply a heavy crushing clamp close to the [illegible] and tie the ligatures

Fig. [illegible]. Lobectomy. [illegible] [illegible] [illegible]. The pleura has been [illegible] and [illegible] [illegible]. The ribs are drawn [illegible] and the [illegible] [illegible] [illegible]. (After Howard Lilienthal.)

deep to [illegible]. If [illegible] employed, leave some of the lobe tissue for suturing over the hilum.

Step 9. Make a stab wound in an intercostal space in the lowest part of the chest and insert a small tube through [illegible] the pleuro-intercostal structures [illegible] interrupted catgut sutures. Approximate the ribs by pericostal or periosteal sutures. (Fig. [illegible].)

Step 10. Close the superficial muscles by [illegible] interrupted cotton sutures. [illegible] the skin. Dress. Return the patient to bed. Give blood transfusions. If the drainage tube becomes blocked, tension pneumothorax may result.

Two-Stage Operation

[illegible] METHOD

Step [illegible]. Make an incision along the length of the [illegible] [illegible] being careful not to injure the parietal pleura. [illegible] [illegible] space into which [illegible] [illegible] inserted.

Step [illegible]. Place the [illegible] over the full length of the [illegible]. This will exert

pressure on the underlying visceral pleura, causing adhesions to form. At the same time [illegible] of the [illegible] takes place.

Step 3. Permit two or three weeks to elapse, then remove the [illegible] and excise lengths of the fifth to seventh or the eighth ribs; expose the [illegible] lobe.

Step 4. By blunt dissection identify the interlobar fissure or [illegible] the artificially produced adhesions and separate the affected lobe down to the hilum.

Fig. [illegible]. Lobectomy. The adhesions are being freed [illegible] [illegible] [illegible]. (After Lilienthal.)

Step 5. Ligate the main branches and vessels with a piece of rubber tubing. Natural separation of the lobe follows in from [illegible] to [illegible] days. [illegible] of blood vessels may be prevented by tying the ligature loosely at first and gradually tightening. The remaining space is obliterated by granulation tissue. In some cases a residual bronchial fistula requires closure.

[illegible] OPERATION

Efforts to produce satisfactory adhesions have not always met with success. The operation of John Alexander of Ann Arbor, Michigan, serves to induce [illegible] inflammation of the pleural surfaces.

Step [illegible]. Under positive pressure anesthesia excise the sixth, seventh and eighth ribs. Vigorously rub the parietal pleura with gauze.

Step [illegible]. Close the wound with the lung in full expansion. This treatment should produce adhesions as well as [illegible] [illegible] which may be repeated if deemed necessary.

Step 3. Ten days later open the chest again and separate the adhesions around the affected lobe by blunt dissection.

Step [illegible]. Transfix the hilum of the lung with [illegible] ligatures; the lobe [illegible] [illegible]. [illegible] [illegible] necessary to separate the [illegible] branches with [illegible].

Fig. [illegible]. Lobectomy. [illegible] [illegible] [illegible] [illegible] [illegible] applied above and below [illegible].

[illegible] [illegible] OPERATION

Cautery pneumonectomy [illegible] employed in selected cases with reported success by Evarts A. Graham. The method consists of subjecting the affected lobe and causing it to adhere and then destroying the lung tissue with the actual cautery. (Fig. [illegible].)

Step [illegible]. Do a [illegible] posterior thoracotomy by excising the lengths of two or three ribs. Produce adhesions by [illegible] the pleura [illegible] by suture and partly closed wound.

Step [illegible]. After [illegible] days the adherent lobe will be found to have decreased in size. The exposed surface [illegible] cauterized with [illegible] [illegible] iron at dull

[illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

Fig. [illegible]. Lobectomy. The stump after lobectomy, together with the ligatures of the pedicle, drawn through an opening [illegible] [illegible] of rubber dam. (After Howard Lilienthal.)

Fig. [illegible]. Lobectomy. Method of closing [illegible]. (W. J. Mayo.)

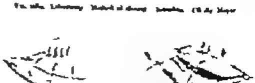


Fig. [illegible]. Lobectomy. Left, Pyramid [illegible]; right, [illegible] [illegible]. (After

red heat (Fig. [illegible]]). Hemostasis is effected by firm packing which is left in place for several days.

Step 3. After three weeks have elapsed, further destruction by the cautery is supplemented by drainage. Bronchial fistulae may form but this is not important.

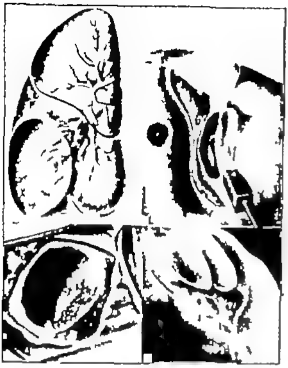


Fig. [illegible]. Graham [illegible] operation of [illegible]. (Graham, Singer and Ballon: Surgical Diseases of the Chest, Courtesy of Lea & Febiger.)

The chief advantages of this procedure are that efficient drainage of the infected bronchi may be instituted in desperately ill patients without having to remove the lobe entirely. Later on, if conditions permit, extirpation of the lobe may be taken into consideration. The chief disadvantage of the procedure [illegible] the length of time required for treatment.

RIENHOFF'S TECHNIC OF TOTAL PNEUMONECTOMY

The preoperative preparation of the patient is of the greatest importance. This consists, first, if possible, in complete collapse of the lung by gradually induced pneumothorax. This diminishes the possibility of circulatory disturbance following the immediate ligation of the pulmonary artery on the affected side and serves to prevent the shock associated with the opening of the pleural cavity. For over two years, Rienhoff has produced an inflammation of the parietal and visceral pleura in order to incite [illegible] pleurisy followed by the formation of granulation tissue because it is much more difficult, if at all possible, to infect [illegible] granulating surface. As [illegible] result of this lining of granulation tissue, in the whole series of Rienhoff' fifty-two cases not one instance of generalized empyema or mediastinitis has occurred.

GENERAL TECHNIC

Step [illegible] A high anterior approach over the hilus, when total removal of the lung is contemplated, is very advantageous. Proper exposure of the lung can be obtained without resorting to the resection of ribs, and at the same time the length of the operation is shortened. In the entire series of thirty-five cases adequate exposure has been obtained by making an anterolateral incision in the third interspace (Fig. [illegible]) and then separating the ribs by means of [illegible] self-retaining retractor. This incision may be made below the line of the nipple and should be carried from the parasternal line in front to the anterior axillary line laterally. If more exposure is desired, it can be continued posteriorly.

Fig. [illegible]. [illegible] incision for total pneumonectomy.

Step 2. *The fibers of the pectoralis major muscle are divided along their course.* This entails no difficulty or impairment of the postoperative function of the muscle.

Step 3. Make an incision dividing the intercostal muscles midway between the third and fourth ribs [illegible] avoid the intercostal vessels.

Step 4. Open the pleural cavity as speedily as possible. (It is surprising how extensive an exposure of the entire pleural cavity can be obtained by mere retraction of the third and fourth ribs.) Occasionally disarticulation of the third or fourth rib at the costochondral junction will occur but this was not followed by bad results.

Step 5. The lung completely covers the hilus on its anterior and superior surfaces (Fig. [illegible] B). The superior surfaces come in contact on both the right and the left sides with the mediastinal pleura. Free and retract this

[illegible] William Francis Rienhoff, Jr., Archives of Surgery, February, [illegible]. Vol. [illegible] pp. [illegible]

lappet which overlies both the right and the left pulmonary artery; the first anterior or ventral branches of the artery are then exposed (Fig. [illegible] C).

RESECTION OF THE LEFT LUNG

Step [illegible] On the left side the extrapleural portion of the pulmonary artery is very short. Three large anterior branches emerge to supply the upper, middle and lower portions of the superior lobe of the left lung (Fig. [illegible]

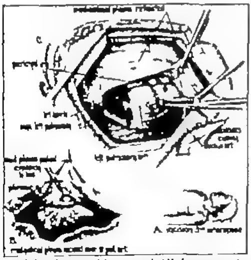


Fig. [illegible]. A shows the position of the patient on the table during pneumonectomy on the left side. An incision [illegible] made anteriorly in the third interspace. [illegible] (Courtesy of Dr. W. F. Rienhoff, Jr.)

A and C), while coursing below and immediately behind the primary bronchus is the large posterior branch. This vessel is difficult to expose and because of its relatively thin wall is very easily and inadvertently torn. The artery fans out, as it were, so that its large posterior and smaller anterior branches intimately embrace the inferior, superior and posterior aspects of the primary bronchus. *Its exceedingly short length between its emergence and departure of these branches gives the surgeon very little room to free the main artery.* The main point of danger is the dissection of the posterior surface of the artery from the anterior aspect of the bronchus, for it [illegible] here that the large posterior descending branch may be torn.

Step [illegible] Control of hemorrhage is also more difficult here than at any other point "because, as Rienhoff says, "the vessels are literally entwined around the unyielding, stiff primary bronchus and can be clamped individually only by the greatest of good luck, the tip of the clamp usually grasping the rigid wall of the bronchus. [illegible] Incise the mediastinal pleura. The areolar tissue

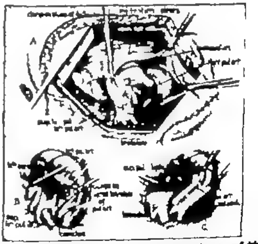


Fig. [illegible]. [illegible] (Courtesy Dr. W. F. Rienhoff, Jr.)

surrounding this portion of the pulmonary artery may be dissected away with ease (Fig. [illegible] C). Between the aorta and the superior surface of the left pulmonary artery [illegible] small bundle of white glistening tissue, the fibrous strands of the obliterated ductus arteriosus (Fig. [illegible] C), are divided and clamped and used as [illegible] retractor (Fig. [illegible] A and B). The posterior surface of the left artery is revealed for [illegible] distance of [illegible] cm. from the point at which the pulmonary artery divides into the right and left pulmonary arteries.

This space (the point of election at which to ligate the left pulmonary

artery) ... extrapericardial and at the superior mediastinum. It is bounded above by the arch of the aorta, behind by the primary bronchus of the left lung and the portion of the pericardial sac covering the left auricle and below by the superior left pulmonary vein, and ... is roofed over by ... small portion of the redundancy of the superior reflection of the pericardial sac but in the main by the mediastinal pleura. The artery is easily separated from the surrounding areolar tissue lying between it and the left primary bronchus posteriorly and the pericardial sac anteriorly. Separate gently the

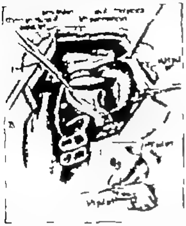


FIG. [illegible] [illegible] (Courtesy, Dr. W. F. Rienhoff, Jr.)

areolar tissue between the artery and its surrounding structures (the aorta, bronchus and the superior posterior portion of the pericardial sac) (Fig. [illegible]-B).

Step 3. Ligate the pulmonary artery which lies just outside the pericardial sac about at the region of the stump of the obliterated ductus arteriosus. Close the mediastinal pleura.

Step 4. Ligate the superior and inferior pulmonary veins in the order named as they are within the pleural cavity.

Step 5. Expose the bronchus to the space on the left side and amputate it high. The posterior membranous portion of the bronchial wall is sutured to the anterior cartilaginous rings. These mattress sutures are placed between the

rings along the stump up to the trachea. Cauterization either with the actual cautery or with chemicals is not necessary. Closure is made with the epithelial surfaces abutting each other just as in suturing the surfaces of the skin (Fig. [illegible]).

Step 6. There are numerous lymphatic glands which lie about the bronchus and can be removed only after an exploration of this space.

REMOVAL OF THE RIGHT LUNG

In total pneumonectomy on the right side, the dissection is slightly different and somewhat more difficult than on the left side. The azygos vein is the best landmark for the beginning of dissection.

Step 1. Incise the mediastinal pleura.

Step 2. Dissect gently the areolar tissue, separating the right pulmonary artery from the azygos vein superiorly, the superior vena cava anteriorly and the superior pulmonary vein and the posterior wall of the left auricle inferiorly

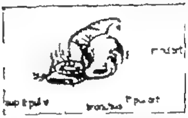


FIG. [illegible]. This diagrammatic sketch shows the stump of the hilus of the left lung which has been dissected, with the vessels and the bronchus ligated individually. It will be noted that the bronchus ... closed with interrupted silk sutures. ... (Courtesy, Dr. W. F. Rienhoff, Jr.)

(Fig. [illegible]-B). The disposition of the branches of the pulmonary artery on the right side differ to some extent from that on the left. Running alongside of the bronchus on the right side is the first ventral or anterior branch, while occasionally ... second anterior branch supplies the lower portion of the upper lobe of the right lung, after which comes the slightly more deeply situated branch to the middle lobe (Fig. [illegible] C). The tributaries to the superior pulmonary vein overlie the lower branch as well as the large posterior division of the artery which is by far the largest of the four.

Step 3. Ligate the superior pulmonary vein intrapleurally. Expose the large posterior branch of the right pulmonary artery (Fig. [illegible] C). The difficulty of making an intrapleural ligature of the right pulmonary artery is at once apparent, for the distance between the inferior margin of the descending branch and the superior margin of the first ventral branch is greater than the diameter of the main right pulmonary artery. However, with careful retraction of the superior vena cava (Fig. [illegible] C) and gentle separation

of the inferior margin of the right pulmonary artery from the pulmonary vein and left auricle, the former may be mobilized proximal to its branches, and ... ligature may be placed around it. The right pulmonary artery is, like the left, entirely extrapericardial, but it ... longer than the latter. Remove the areolar and lymphadenoid tissue.

Step 4. Excise the mediastinal nodes and take care of the bronchus.

Step 5. Remove completely all the tissue of the lung together with the lymphatic vessels. While ... may be possible in some instances to remove the lung by placing mass ligatures around the hilus without dissecting out the vessels,

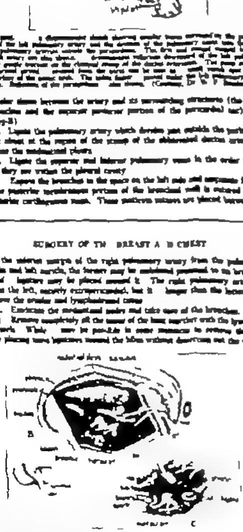


FIG. [illegible] [illegible] (Courtesy, Dr. W. F. Rienhoff, Jr.)

In many instances the tumor of the lung that is left in such an unsurgical procedure will already have been invaded by the malignant tumor and recurrence is certain.

Step 6. Closure of the wall of the chest should be simple. Three pericostal braided silk sutures are placed through the second and fourth interspaces and encircle the third and fourth ribs. The latter are then held together by ... rib approximator while the sutures are tied.

Step 7. The overlying pectoral muscle and fascia are brought together with interrupted silk sutures. The skin is closed in ... similar manner.

Step 8. Drainage of the thoracic cavity is not resorted to.

Comment. In all of Rienhoff's ... cases tribrom ethanol in amylene hydrate was used, the dosage being 80 mg. per kilogram of body weight, by rectum. This basal anesthetic was supplemented with nitrous oxide and oxygen given, except in two cases, without an intratracheal tube. A high percentage of oxygen was used during the operation with ... small percentage of nitrous oxide. The anesthesia was very light, and the movements of the diaphragm and mediastinum, after one had become accustomed to the rhythm, were of no great inconvenience. Rienhoff is against the use of tracheal tube because of the trauma it inflicts and because of the possibility of infection.

The position of the patient in bed after operation is of prime importance in preventing respiratory complications. It is advisable to adopt the Trendelenburg position with the foot of the bed elevated for the twenty-four hours following the operation, thus producing free bronchial and tracheal drainage with the minimum effort on the part of the patient. Avoid tight bandages. After forty-eight hours, the patient can be put in ... semi-sitting posture, but he should never be kept in one position throughout the twenty-four hours. The elevation of the bed and the position of the patient in the bed should be changed every two hours during the day and night.

CHAPTER 28

SURGERY OF THE PULMONARY ARTERY

Anatomic Considerations. The pulmonary aorta, often called the pulmonary artery, originates at the top of the conus arteriosus of the right ventricle. It is about [illegible] inches long and follows an upward, backward direction turning slightly toward the left. Under the aortic arch it separates into the right and left pulmonary arteries. It is covered throughout most of its length by the visceral layer of the pericardium which surrounds it and the basal part of the systemic aorta. At its source it is partly overlapped in front by the tip of the right auricular appendix and at its back it is related to the base of the systemic aorta and the proximal part of the right coronary artery. It lies to the left of the systemic aorta, more distally and even upon the anterior surface of the left auricle.

In discussing the surgery of the pulmonary artery, Willy Meyer of New York stated:

The trunk of the pulmonary artery is easily accessible. On longitudinal incision of the pericardium, to the outside of the phrenic nerve up of the left phrenic nerve and vessels which run right on the surface of the sac, the first vessel encountered is the pulmonary artery. Its direction is obliquely upward and backward toward the left. The forefinger or a large curved sound introduced right below it in a backward and upward direction toward the right of the patient enters the transverse sinus of the pericardium and passes around the artery and ascending aorta, which latter lies on the right side of the pulmonary artery. Both vessels are intimately connected by means of connective tissue and are surrounded by the same layer of the visceral pericardium. It is impossible to separate them. There is no defined sheath of the pulmonary vessel; this layer of subserous fat presents itself after the pericardium has been opened. The main trunk of the pulmonary artery lies almost entirely within the pericardium and is about five centimetres (two inches) long. At the concave border of the aortic arch the vessel divides into the right and left branches. The right, longer than the left, turns downward and backward around the ascending aorta, passes the superior vena cava, and divides into two branches, an upper and a lower one, at a level with and right after the right bronchus, before it enters the hilus of the lung. Further on, these two again divide, the pulmonary artery branch always running to the north of the respective bronchus. This is an important anatomic point. The left (shorter) main branch of the pulmonary artery first continues in the original direction of the parent trunk but soon turns downward in front of the left bronchus and the descending aorta toward the hilus of the left lung. There are many variations in the subdivisions of the pulmonary vessels.

PULMONARY EMBOLISM

Howard Lilienthal, in a paper before the surgical staff conference of Mount Sinai Hospital, said, in speaking of pulmonary embolectomy:

"Six per cent of all deaths following surgical operations are caused by pulmonary embolism. My authority for the above statement is a paper by Mahorner and Ochsner as well as a letter from Dr. Alton Ochsner giving reference to

Annals of Surgery, Vol. [illegible], [illegible]

the literature with calculations based on an ample number of cases (more than [illegible] thousand). He also notes not a bit of literary investigation by [illegible] that not a single successful pulmonary embolectomy has been performed and recorded in the United States.

"Long before these striking statistics were brought to my notice, I had resolved to do whatever was in my power to arouse interest in this subject so that we might no longer fail to do our best in this terrible accident provided the patient is in good general condition. Refusal to act merely because the lesion happens to involve a structure rarely the site of operative procedure is unworthy of the profession of surgery.

In 1930 an important paper was read by Gunnar Nystrom of Upsala, Sweden, on pulmonary embolectomy (Trendelenburg operation). Up to that time fourteen patients had survived operation, of whom seven were 'discharged healed' (50 per cent). Thirty operations, more or less, had been published and probably many more had not been reported. In the discussion (loc. cit.) I stated that, even though in America we do not all have permanent first assistants as is the custom abroad, there is no reason why interns in training in the particular hospitals, and those in our hospitals, there is no reason why the diagnosis of embolism, should not be given to operations, as well as in the diagnosis of embolism, should also be taught to recognize the properly qualified House Surgeon who should also be taught to at once give the alarm and symptoms of pulmonary thrombosis so that he may at once give the alarm and have the patient transferred to the operating room. It must be remembered that patients apparently dead have been resuscitated and have fully recovered after the extraction of emboli from the pulmonary artery.

"Elliott C. Cutler states that his resident surgeons up to 1934 had operated in four cases. The operations were not successful, and Cutler believes that they were all done too late. Cutler's conclusions are practically the same as those expressed by my own remarks three years earlier. The entire matter was of preparedness. Cutler agrees with me that the resident staff of our hospitals should be authorized to attack the problem in the individual case, though he qualifies his words by saying that 'any good young surgeon who has had five or six years of competent training should be able to perform the operation.'

"Dr. J. C. White in the discussion of Cutler's paper differs somewhat, saying that the procedure is not so simple as represented and that the diagnosis is not always easily made. While I admit that the recognition of the accident may not be possible in one per cent of the cases, yet the errors disclosed at operation have been extremely rare—much more infrequent than those found at operation in other emergencies.

Auerbach recently pointed out the possibilities of error in differentiating acute coronary thrombosis from pulmonary embolism, and others have stressed the matter of diagnostic accuracy. Yet, following along clinical lines, it must be conceded that when life is threatened by any other acute surgical complication and the patient is otherwise a good risk, few surgeons will hesitate to act even though there be only one chance in many to save life.

"Thoracic surgeons with whom I have spoken agree in principle that the only hope in massive pulmonary embolism is by direct attack, not only in cases in which previous operation has been performed, but also in medical disease and in obstetrics.

"Literature dealing with the technic is still scanty but American surgeons

are discussing the matter more and more freely and results are sure to follow. Crowell presented two unsuccessful cases, one of which might have resulted in recovery but for delay. Meyer in 1913, devised a simplified approach directly through the pericardium and was fortunate enough to save three patients.

"But that is all beside the mark. My earnest wish is that there should be no delay in mapping out a plan for this great clinical and economic advance. The medical, surgical, and nurse staffs of the hospital and the head nurses should be molded into a carefully worked out organization, and should, in my opinion, be instructed in every detail. But whatever the plan, it is urgent that, for in the absence of embolectomy, things should be ready for the treatment of the emergency. The first successful case in this country will mean much to American surgery and, incidentally to the hospital which has had the foresight to be ready for effective action.

PULMONARY EMBOLECTOMY—TRENDELENBURG OPERATION

In man, the best method known at present of obtaining access to the main trunk of the vessel is that devised by Trendelenburg. In experimental surgery upon dogs an intercostal incision in the third or fourth interspace with the use of rib-spreader suffices for proper access.

The Trendelenburg operation as finally worked out, is briefly as follows:

Step 1. A horizontal incision about ten centimetres long is made upon the left second rib, beginning at the left border of the sternum and dividing skin, fascia and fibers of the pectoralis major muscle.

Step 2. This is crossed by a perpendicular cut which starts right below the sternoclavicular articulation and passes the cartilage of the third rib about one inch outside of the sternal border towards the left internal mammary artery (or the incision depicted may be used, Fig. [illegible]).

Step 3. The flaps with the underlying muscle are turned back.

Step 4. Isolate and divide the second rib (Fig. [illegible]). In raising and twisting the sternal portion of the rib the cartilage breaks. This portion of the rib is removed.

Step 5. Divide the third cartilage in a perpendicular line. Usually by this time the pleura has been opened and the use of differential pressure is of great value provided time and a sufficient number of assistants are at the surgeon's disposal. If the pleura has not been opened an incision through it, corresponding to the outer one, has to be made. The lung is allowed to collapse, somewhat, and thereby the pericardium exposed. Upon it the phrenic nerve and pleural vessels become visible.

Step 6. Inwardly of the nerve the pericardium is incised at the level of the third rib and the wound lengthened in an upward and backward direction until the entire upper half of the pericardium is divided, the lower half remains closed and the heart itself remains in its normal position. All this can be done well within five minutes.

Step 7. A rubber tube with the help of Trendelenburg's sound (Figs. [illegible]) is then quickly drawn through the transverse sinus of the pericardium around the ascending aorta and pulmonary artery, held and pulled upon for compression by an assistant, immediately before the

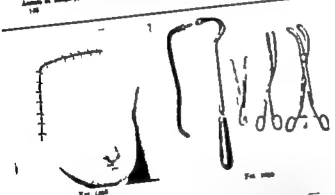


Fig. [illegible]

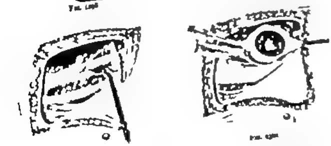


Fig. [illegible]

Fig. [illegible]. [illegible]

[illegible]

surgeon punctures the vessel with sharp-pointed scalpel. The presenting thin layer of fat with the visceral pericardium having been torn, if necessary, the wound in the arterial wall is lengthened with care between two anatomical forceps for about one centimeter (⅓ inch).

Step 8. Without moment's loss of time specially curved, blunt forceps is introduced, first into the main artery, then into its branches, the thrombus or thrombi are grasped and extracted. Only 45 seconds are at the disposal of the surgeon for this, the principal part of the operation, since observations have shown that the interruption of the circulation in this part of the body is not tolerated longer.

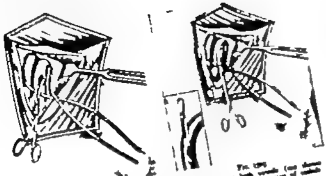


Fig. 1294. Fig. 1295.

Fig. 1294. Thrombus removed by forceps ... (Willy Meyer.)

Fig. 1295. Longitudinal wound in pulmonary artery closed ... sutured in transverse ... (Willy Meyer.)

Step 9. Now the lips of the vessel wound are lifted up by special forceps and temporarily closed by clamp, after which the constant interrupts the elastic compression. Circulation therewith having been re-established the heart immediately begins to contract, often violently if the patient has not died before. If needs be, the massage of compression, suspension of the arterial wound and introduction of this forceps can be repeated.

Step 10. Closure of the wound in the pulmonary artery by interrupted silk sutures is rendered easier by pulling at intervals on the elastic tube, which will put the artery at rest for few seconds.

Step 11. Close the wound of the pericardium and chest according to ordinary surgical rules.

Paul Trendelenburg wrote: All new and difficult problems require much work, favorable conditions and unfaltering steadfastness and perseverance. This holds good also in the operation for pulmonary embolism. Twelve times have we done it at the least, my assistants oftener than myself, and not once with success. And yet, I would continue trying. This much we have learned from our cases, that the diagnosis in all surgical cases is very favorably did we find the emboli.

Trendelenburg operation is wisely adapted to the endeavors of prevent cases. The ideal way of dealing with an acute arterial embolism is to cut down on the seat of the thrombus after proper localization, remove it and close the rent of the arterial wall by suture. Trendelenburg deals with the most common form of embolic troubles which, if left alone, are frequently fatal. He has succeeded in overcoming the technical difficulties that seemed at first glance to block the way. The steps of his operation are clearly defined.

If it could be shown that patients can entirely recover after the operation, surgeons would, no doubt, be less inclined to temporize, but would operate as soon as the diagnosis has been made.

All surgeons speak of the enormous distention of the right ventricle of the heart after the onset of the catastrophe which, as matter of necessity increases from minute to minute.

Trendelenburg, Anderson, Lawson and Sievers, on the basis of experimental work, recommend artificial respiration with oxygen during the operation, and injection of adrenalin into the left ventricle, immediately after the elastic compression of the vessels has ceased. They also found that the aorta and pulmonary artery can be compressed for from six to eight minutes without endangering life, point which had already been emphasized by Sauerbruch previously. The explanation is that as the former case the distention of the right heart is added to the interruption of the circulation. On the basis of these findings, Jeger proposes compressing the two big veins, when carrying out Trendelenburg operation, rather than the two big arteries. In his experiments along these lines he found that he could do the incision and closure of the pulmonary artery leisurely. The incision of the pulmonary artery brought immediate relief to the distended right heart. He thinks it might be still better to commence work on the heart with puncture of the right ventricle.

According to Trendelenburg, coagulation of the blood and recurrence of the embolic accident can be avoided by injections of hirudin. The embryonic, Rosenthal and Wolf, investigated this question. They found that one milligramme hirudin prevents the coagulation of 5 cc. of blood for four and one-half hours. This would mean for patient of average weight grammes (5 grains) of pure hirudin. Since expensive procedure, at the cost of one gramme hirudin is about five to ... The drug injected intravenously in large amounts, proved harmless.

Some authors have called Trendelenburg operation of little practical value because of the embolus is large, the patients die often few minutes, and if it is of smaller size, it often does not endanger life and the patients do not need operation.

However, according to Trendelenburg's experience, these remarks certain proportion of patients, at least 50 per cent, in whom only one branch of the ...

Die Chirurgie der Brustorgane u. des Herzens, ...

pulmonary artery becomes obstructed at first, and death does not occur until ten to fifteen minutes after the onset of the embolic attack. These patients present clear indication for his operation. At least 15 minutes are usually at the disposal of the surgeon. Assistants and nurses must be trained to complete the attack.

A. W. Meyer in an illuminating contribution pointed out that

Opening of the pleura increased shock considerably conditions not well borne by an already damaged heart.

Trendelenburg's forceps which are put on the side of the pulmonary artery for the purpose of suture are too wide, therefore, encroach too much upon the section through which blood has to pass.

That the tube covered rubber tube covering the forceps is not very effectual because causes the forceps to slip.

The seconds of strangulation to which the large vessels are subjected during the compression with the rubber tube is too long, thus and causes irreparable paralysis of the respiratory center.

Meyer's studies on the cadaver have shown that

Opening of the pleura may be avoided.

The modification of the Trendelenburg's forceps permits the circulation of the blood in the pulmonary artery to continue without much encroachment.

Slipping of the forceps may be avoided by gauze covering instead of rubber.

A. W. Meyer Technic

Step 1. Make the usual skin incision, expose the second and third ribs.

Step 2. Ten to twelve cm. of periosteum are stripped off from the ribs such as necessary. Work fast but cautiously. This will avoid opening the pleura. With the index finger of the right hand introduced into the lower medial angle and palpating between the sternum and the attachment of the third rib, push the pleura and the mammary artery gently out of the way. The pericardium where absence membrane covered in places with fat, is now easier to clear. Fig. 1296.

Step 3. Incise the pericardium. Fig. 1297. As you can introduce two fingers into it. Spread the opening of the pericardium gently but with firmness, so that both fingers may be introduced with ease. By so doing, the pleura glides farther out of the way and the pericardial cavity may be opened with astonishing facility. On occasions, particularly when one practices on the cadaver, doubt often arises whether the vessel presenting is the aorta or the pulmonary artery. In the living subject the pulmonary artery presents itself promptly, much distended, firm and pulseless. Encircle the pulmonary artery with Trendelenburg tube. Fig. 1298.

Step 4. Enlarge the incision in the pulmonary artery upward for about one, while the rubber tube remains loose (Fig. 1299). Immediately dark

Arch. Klin. Chir., 1909.

Fig. 1296. Embolectomy (Meyer). Incision. Resection of ribs. Ligation of arteries.

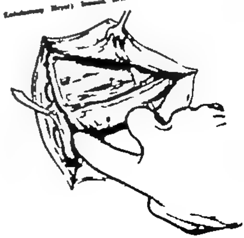


Fig. 1297. Embolectomy (Meyer). Pushing away of pleura. Opening ...

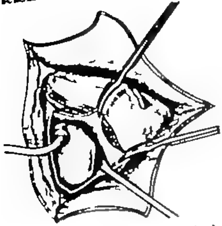


Fig. [illegible] Introduction of rubber tube. (A. W. Meyer.)

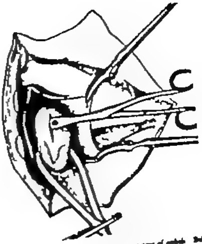


Fig. [illegible] Clamping of right branch of pulmonary artery [illegible]. Rubber tube [illegible]. (A. W. Meyer.)

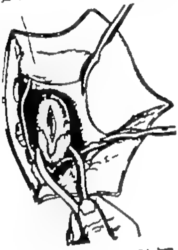


Fig. [illegible] [illegible] pulmonary artery. Tube [illegible]. (A. W. Meyer.)

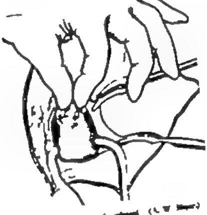


Fig. [illegible] Rubber tube released. (A. W. Meyer.)

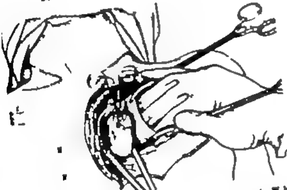


Fig. [illegible] Clamping out of the left branch of the pulmonary artery [illegible]. (A. W. Meyer.)

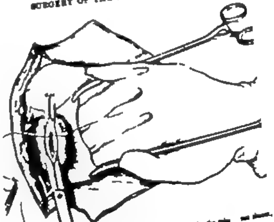
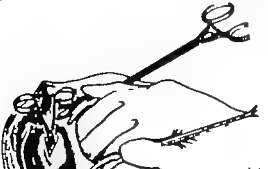


Fig. [illegible] Application of [illegible]. Suture. For clarity only the tube [illegible] removed only after the clamp [illegible] removed. (A. W. Meyer.)



[illegible] Suggested method of compression of pulmonary artery. Tube released. (A. W. Meyer.)

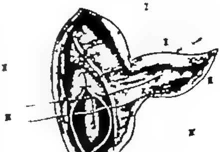


Fig. [illegible] Suture of pericardium. (A. W. Meyer.)

blood. It frees washing out emboli that may spring from the heart. Allow this to continue for a while for, as Schumacher has shown, this will tend to relieve the right ventricle. Now tighten the rubber tube once more.

Fig. [illegible] Extraction of embolus with vacuum suction apparatus. (From sketch kindly sent the author by Prof. Nystrom.)

Step 5. Enter the right branch of the pulmonary artery with the Trendelenburg embolus forceps (Fig. [illegible]) in a horizontal position. If the right branch of the pulmonary artery is free (entering it about 3 times is sufficient), quickly grasp the opening in the pulmonary artery with the thumb and index finger of the left hand, closing it. Now release the rubber tube. Permit the blood to run through the pulmonary artery for a few seconds (Fig. [illegible]).

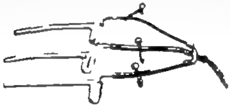


Fig. [illegible] Vacuum suction apparatus. (From sketch kindly sent the author by Prof. Nystrom.)

Step 6. Tighten the tube (Figs. [illegible]). Enter about 3 times into the left main branch of the pulmonary artery. Give the heart some rest now by loosening up the rubber tube and again compressing with the fingers the opening in the pulmonary artery. Now for the second time pull powerfully on the tube. With a curved forceps in the left hand grasp the upper

end of the incision in the pulmonary artery which is pulled upward, while the right hand hugs the vessel tightly. Apply vessel clamp and release the rubber tube.

Step 7. Suture the pulmonary artery with interrupted sutures. This must be done carefully in order to avoid tears in the vessel wall (Fig. [illegible]). One must remember that the pulmonary artery is brittle. When the suture is completed, open the forceps, pull the sutures left long upward and see if there is any bleeding. If so, reapply the forceps and introduce additional sutures.

Step 8. When everything is dry close the pericardium (Fig. [illegible]).

Comment. Instead of forceps, Professor Gunnar Nystrom of Upsala uses suction to clear the pulmonary artery of emboli. He graciously sent me his original drawings depicting the suction apparatus and its use (Figs. [illegible]).

Annals of Surgery, Oct., [illegible].

CHAPTER 39

SURGICAL APPROACH TO THE MEDIASTINUM

Anatomic Considerations. Excepting the larynx and a portion of the trachea, the thorax contains all organs of respiration. The lungs take up the largest part of this cavity, extending laterally from the vertebrae to the sternum. The space between the pleurae is called the mediastinal space and is divided into four sections called mediastina. The superior mediastinum occupies the plane extending from the disc under the fourth thoracic vertebra to [illegible] the first and second pieces of the sternum [illegible] the thymus, aortic arch and branches, the innominate veins and superior vena cava are found here. The trachea, esophagus, thoracic duct, the pneumogastric, phrenic and sympathetic nerves pass [illegible]. The area under the plane referred to above is divided by the pericardial sac into an anterior, middle and posterior space. The heart is located in the middle mediastinum; here also is found part of the roots of the lungs. The lower part of the thymus, a few lymph-nodes, fat and areolar tissue are found in the anterior mediastinum. The esophagus, aorta, thoracic duct, azygos veins, pneumogastric and sympathetic nerves are found in the posterior mediastinum.

MEDIASTINOTOMY

TRANSSTERNAL MEDIASTINOTOMY (MILTON'S OPERATION)

A description of Lilienthal's modification of this procedure follows. It is particularly applicable in substernal growths, often goitrous, but it may also be employed in dealing with infections.

Anesthesia. [illegible] inhalation anesthesia may be employed. Guard the *field of operation by some form of screen. Facilities must be at hand for intrapharyngeal* positive pressure in case one or both pleurae be entered.

Step [illegible]. Make a low collar incision (Fig. [illegible]). If the substernal mass is continuous with the thyroid tissue in the neck, work the finger carefully down, keeping close to the substernal growth, gently free the tumor from its adhesions as far as possible. If hemorrhage is encountered, it must likely be venous and it ceases when the finger is withdrawn.

Step [illegible]. Make a vertical incision from the interclavicular notch almost or quite to the xiphoid, carrying the incision down to the bone. With a chisel, osteotome or Schumacher sternum shears split the sternum from the interclavicular notch as far down the gladiolus as seems necessary, judging by the estimated size of the tumor. At the end of this longitudinal incision the bone section is continued at right angles, left and right, at the level of an interspace. The sternum is apt to bleed freely. Work with dispatch.

Step 3. When the bone section has been completed, divide the retrosternal periosteum. Retract right and left with sharp-pronged retractors in the bone. Gradual exposure of the mediastinum through a cleft at least [illegible] inches in width is to be accomplished. Bleeding from the bone may be checked by rubbing a bit of muscle into the cut surface. Danger of injury to the internal mammary vessels is slight. If these vessels should accidentally be [illegible], the bleeding point must be secured by [illegible] cartilage.

Step [illegible]. Through the transsternal mediastinal exposure the tumor can be pushed

upward toward the neck and eventually delivered through the superior aperture of the thorax.

Comment. Lilienthal admonishes that in carrying out this maneuver the thyroidea ima artery, which when present usually arises from the aorta itself, must be borne in mind. The vessel is often of considerable size and can be recognized and secured before it is divided. He further remarks:

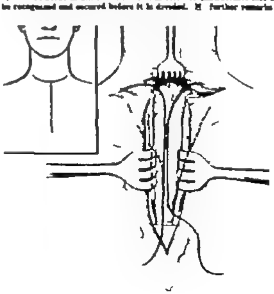


Fig. [illegible] [illegible] transsternal mediastinotomy as modified by [illegible] Lilienthal. [illegible] courtesy of Dr. Lilienthal.

"If ordinary inhalation anesthesia has been employed, the motion of the pleural sacs oscillating with respiration alternately away from and toward the central plane of the body will be seen, and the excursions are often so great as to be almost alarming. A little intrapharyngeal air pressure will cure this and breathing will become more placid. Through this exposure the motion of the heart within its sac can also be clearly observed. After careful inspection for hemorrhage the wound may be closed with sutures through the skin alone which, being still adherent to the sternum, will draw the halves of this bone into apposition.

If the possibility of infection is suspected, drain by [illegible] this piece [illegible]

gauze placed under the sternum before entering and leading out through the median line at the root of the neck.

T. P. Dunhill[1] modification of the transsternal operation consists of creating a trap door of half of the sternum from the suprasternal notch as far down the gladiolus as necessity demands. The flap consists of the sternal portion, together with part of the clavicle and the required number of ribs.

PARASTERNAL (ANTERIOR) MEDIASTINOTOMY

In draining the anterior mediastinum when an effusion or exudate pushes to one side or the other of the sternum, then stripping the pleura away the anterior mediastinum may be reached without perforating or splitting the sternum.

Technic. A T-shaped parasternal incision is made and one or more costal cartilages are resected mesial to the internal mammary vessels. For drainage the removal of a section of only one cartilage will give wide exposure. This operation is applicable when encapsulated fluid (cold abscess) is to be attacked.

Tuffier[1] explored the upper part of the anterior mediastinum through an incision in the third intercostal space; he pushed the pleura aside and palpated the lung through the unopened pleura after pushing it away from the chest wall in search of tumors which he recognized by the increased resistance of the tumor.

SURGICAL APPROACH TO THE POSTERIOR MEDIASTINUM

Lilienthal's Operation

Any part of the mediastinum may be approached posteriorly without entering the pleura. The operation is indicated when drainage is sought, for the removal of neoplasms or other pathological entities and as an exploratory measure.

Nassiloff, Bryant, Enderlen and others enter the posterior mediastinum by multiple rib resections or by making a trap door of ribs and soft parts swinging upon a vertical hinge. Lilienthal found the best approach to the posterior mediastinum to be one which depends upon the retraction of the divided ribs at right angles to their long direction, changing them one on the other, making the deep exposure from below upward, the extent of available space being determined by the length of the wound, especially that portion which divides the intercostal extrapleural structures.

The patient should be placed upon the side opposite the proposed approach, and turned about 30 degrees toward the front so as to bring the field of operation to the most convenient position for the surgeon. The thighs should be flexed and held by straps passed under the table (Fig. 1269). The arm beneath may be a little behind the patient, the other drawn forward and a little upward. The position of the body must be maintained by means of large sand-pillows. A pillow or the bridge of the operating table will raise the body into a moderate scoliosis.

Ether or nitrous oxide and oxygen or a combination of both should be

[1] Rapport au Congrès International de Chirurgie de Londres, August 1913.
[2] Howard Lilienthal, "Thoracic Surgery," W. B. Saunders Co., 1925.

used as an anesthetic. If a general anesthetic is used preparations must be made for the immediate application of differential pressure, because of the danger that both sides of the chest may be opened when stripping the pleura forward. At the level of the eighth and ninth dorsal vertebrae the right pleura often tends to fold across the midline line for an inch or more into the left chest and if the left pleura has been accidentally torn and the right is also opened, death will quickly follow unless there is positive pressure in the air passages or negative pressure in the wound. If neither pleural sac is injured ordinary inhalation narcosis is all that is necessary.

Posterior mediastinotomy may be performed on the left or the right side and it may be divided into two main types, low and high.

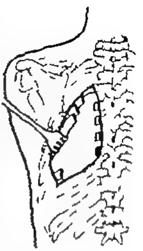


Fig. 1302. Posterior mediastinotomy by Lilienthal method. Incision [illegible] Division of [illegible] and [illegible] of ribs over each other. [illegible] (From Lilienthal, Thoracic Surgery, W. B. Saunders Co.)

Low Posterior Mediastinotomy

Step 1. Make an incision upon the tenth rib beginning 3 or 4 inches from the spine and running backward along the rib to the edge of the long spinal muscles, then curving upward parallel with the spine for four or five interspaces.

Step 2. Resect the ninth rib subperiosteally as far as the wound will permit (Figs. 1302-1306). Ample access to the posterior mediastinal space can be accomplished with much shorter resection or possibly even by merely dividing the ribs. The parietal pleura is extremely thin and will easily tear.

Step 3. Insert the finger slowly between the posterior unresected part of the rib and its periosteum, pushing the membrane and the pleura forward away from the posterior chest wall. Stripping in this region is easier because the attachment of the pleura to the parietes is much less intimate here than more anteriorly. After the pleura has been separated from the eighth rib this bone can be divided with powerful cutting forceps, the finger passing under the rib acts as a guard.

Step 4. Separate the pleura, beneath which the lung can be seen smoothly gliding, still further forward, using two or three fingers of the right hand for the purpose. The seventh rib is treated as was the eighth. The stripping becomes easier as it proceeds upward and often the pleura literally falls away from the mediastinum, especially above.

Fig. [illegible]

Step 5. Divide as many of the next upper ribs as may be required close to the spine, strip the pleura and lung forward with increasing gentleness until it appears that enough space has been made (Fig. 1303). Insert a flat, broad blunt retractor against the lower edge of the eighth rib at right angles to the rib exposing the first landmark, the great splanchnic nerve, as it lies upon the posterior chest wall part way up the elevation formed by the bodies of the vertebrae (Fig. 1303).

Step 6. Push the pleura still farther forward and the descending aorta and

Fig. 1303

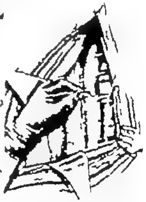


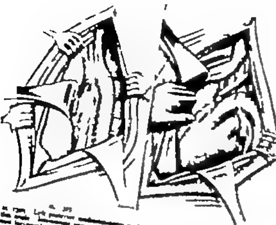
Fig. 1304

Fig. 1303. Pushing the pleura from the dorsal to aorta. [illegible] splanchnic nerve.

Fig. 1304. [illegible] (From Lilienthal, Thoracic Surgery, W. B. Saunders Co.)

lies bare together with the fascia-covered left part of the vertebral bodies (Fig. 1303). In front we now have the esophagus with the periesophageal nerves, the right, more posterior one, being easiest to locate (Fig. 1304). The [illegible] recognition of the esophagus by sight or touch is not easy even when a good sized stomach tube has been inserted through the mouth as a guide. Lilienthal therefore devised a diaphanoscope which consists of a rubber tube, 30 to 40 French calibre, into the end of which is fitted a little electric lamp, the wires passing through the tube to a small hand battery. This is passed into the gullet through the mouth by an assistant and the light is then flashed down through the tumor with a bright crimson glow instantly indicating the location of the lumen of the organ. The esophagus is nearly always carried forward with the pleura and pulmonary ligament much as the ureter is drawn forward with the peritoneum.

Step 7. The ... net-like layer of tissue which holds the esophagus and the descending aorta together and is continuous with the adventitia of the artery and probably with the pulmonary ligament. This may be lifted from the vessel with forceps, divided with scissors, and partly stripped away to facilitate orientation of the esophagus. Rolling the aorta from its position is dangerous; its intercostal branches on the far side may be torn and the resultant hemorrhage may be difficult to control.



In exposing the esophagus guard against vagus shock and avoid entering the pleura. The vagus may be temporarily blocked (Turek) by applying to the nerve above the place where the dissection proceeds 1 per cent cocaine ... Every effort must be made to identify the right pleural reflection. The outer layer of the esophagus consists of muscle which can easily be torn by rough handling and the lumen of the gullet accidentally opened.

Step 8. Identify the right, more posterior vagus with its plexus gullet and divide the nerve branches of the plexus with scissors ... drawn in under the esophagus. The left vagus ... usually not seen.

Step 9. Draw aside the pleura and lung with a large broad retractor and expose the posterior wall of the pericardium.

In freeing the esophagus downward ... and the nerves accompanying ...

be followed forward to the hiatus in the diaphragm. It is not always easy nor possible to peel the pleura away from the central portion of the diaphragm.

High Posterior Mediastinotomy. This operation is carried out on the same general plan as the preceding operation just described (Figs. 351-354).

Step 1. Here the seventh or even the sixth rib is first resected, and the fifth, fourth, and third are divided posteriorly. At this level the approach may be from right or left, but in contemplated operations upon the esophagus the right side is preferable.

Step 2. The trapezius and rhomboid muscles are divided and the scapula drawn far forward.

Step 3. The separation of the pleura from the chest wall is distinctly easier than it is below and the sac with its contained lung may be pressed downward from the superior opening of the thorax, exposing the entire aortic arch with its branches. The trachea and its bifurcation, the esophagus, and the other structures of this region can be seen and handled with facility. The operation now proceeds above the cardiac branches of the vagus, so that ... of the pneumogastrics is more important here than it is below. In the right-sided operation the azygos vein must be ligated and cut. The esophagus is then easily found where it passes behind the aortic arch.

Comment. In diffuse infections of the posterior mediastinum, even when the condition extends to the superior portion, drainage must be of the evident kind and at the time of operation. Vaselined gauze or rubber dam with gauze placed upon it is used (Mikulicz). Tubes should be avoided except for draining pockets. Here soft black rubber tubes may be ... employed. Do not disturb the original packing for four or five days or even longer. In about ten days the drainage must be changed daily. Be sure that there are no undrained pockets.

Accidental opening of one pleura does not necessarily mean that the operation must be immediately abandoned. Differential air pressure permits the operation to be continued. When the wound in the pleura is too large for suture or the pleura is too fragile to hold the sutures, cover the rent with gauze or rubber dam, pack the remainder of the mediastinum and close the external wound. In ... few days the lung will expand and seal off the rent in the pleura.

CHAPTER 30

SURGERY OF THE ESOPHAGUS

Historical Notes on the Surgery of the Esophagus. It is interesting to ... the development of esophagoscopy ...

[illegible]

The two vagi nerves form ... plexus known as the plexus gulae ... which is situated around the esophagus. As the esophagus passes through the diaphragm, the left vagus lies in front of it and the right vagus behind it. It enters the abdomen ...

The Course of the Esophagus in the Thorax. From the fourth to the seventh thoracic vertebrae the esophagus ... to the left of the median line.

The constricted portions of the esophagus are four ...

Congenital Anomalies.

Absence of the lower part.
Tracheo-esophageal fistula.
Esophageal atresia.
Congenital strictures.

Diverticulae are usually in the upper part of the esophagus and are acquired ...

Blood Supply. ...

Veins. ...

Lymph drainage ...

Nerve Supply. From Two Sources. ... Parasympathetic, through the vagus and recurrent laryngeal nerves. ... Sympathetic, through the cervical and thoracic portion of the sympathetic chain.

Strictures of the Esophagus. ... Spasmodic (temporary). (b) Fibrous (cicatricial). (c) Malignant (carcinoma).

ESOPHAGOSCOPY

Many years ago Sir Morell Mackenzie considered the esophagoscope an instrument requiring the "instinct of ... sound swallower and the eye of ... hawk." Today ... used routinely in conditions where pathology of the gullet is suspected.

Esophagoscopy may be done under local or general anesthesia. Local anesthesia ... applied as previously described. However, general anesthesia will often give ... greater relaxation, especially of the crico-pharyngeal muscle.

The position of the patient is that described for bronchoscopy. The larynx and hypopharynx are first examined with a laryngoscope to determine if any pathology is present around the mouth of the esophagus. The esophagoscope (Fig. 357) either the Mosher or Jackson type is passed down the right side of the tongue and into the right pyriform sinus. This is done under direct vision, care being taken to avoid injury to the posterior pharyngeal wall. When the tip of the esophagoscope is well into the pyriform sinus it is swung to the midline. It is then behind the arytenoid cartilage. The opening of the esophagus will be seen to be "winking" at the operator. The passage through the crico-pharyngeal constriction is the most difficult part of esophagoscopy. A small amount of steady pressure will allow the esophagoscope to enter the esophagus. Care is exercised as an abrasion of the mucous membrane may lead to ... fatal mediastinitis. After the instrument is in the esophagus it will pass ...

rather easily all the way to the cardia. However this should be done slowly under direct vision, keeping all the walls of the esophagus in clear view to avoid any injury. No undue force should be exerted. If a constriction is encountered it should be investigated with a small bougie and the esophagoscope should not be forced into the opening.

Fig. 1107. Jackson esophagoscope.

OPERATIONS ON THE ESOPHAGUS

REMOVAL OF FOREIGN BODIES

This is indicated in removing obstructions (foreign bodies) in the cervical and upper dorsal portions of the esophagus.

Step 1. The position of the foreign body is ascertained by the passage of good sized esophageal bougie (Fig. 1108) supplemented by, if conditions permit, x-ray or the esophagoscope.

Step 2. Expose the sheath of the carotid vessels. Displace the carotid vessels outward, retract the thyroid gland and draw it inward. The skin incision should be liberal.

Fig. 1108. Esophageal bougie for stricture of the esophagus.

Step 3. Identify and outline the pharynx. Draw it forward and search by palpation for the obstructing foreign body. If not found, pass a substantial sized bougie down the esophagus to the point of obstruction. The bougie distends the esophagus. Identify the lumen.

Step 4. Pick it up with a pair of Allis or tissue forceps and incise it longitudinally, avoid injuring the recurrent laryngeal nerve. Locate the obstruction by probing.

Step 5. Grasp the foreign body with forceps and remove it aided by manipulation from without. If the incision in the esophagus is found too small for the manipulation necessary to dislodge the obstruction, enlarge it sufficiently to permit careful and successful manipulation.

Step 6. Close the opening in the esophagus with two rows of fine catgut sutures, the first embracing the mucous membrane only and the other suture superimposed. Do not attempt completely to close the opening in the esophagus if the mucous membrane has been damaged during the extraction of the foreign substance.

Step 7. Drain. Pack lightly with gauze. Keep the wound clean.

Precautions. Do not mistake the foreign body for an enlarged and calcified lymph node or the esophagus for the longus colli muscle. Remember that the [illegible] distension and collapse of the esophagus help to identify it. If in doubt, explore upward and downward until the foreign body is located. Control all bleeding points promptly during the operation. It is wise to avoid [illegible] as far as possible of the inferior thyroid artery, anterior jugular vein and recurrent laryngeal nerve in order to avoid injury to these structures. The latter is avoided if the incision in the esophagus is made as far posteriorly as practicable. According to [illegible], the index finger may be introduced into the esophagus through a low cervical incision (low cervical esophagotomy), passed to the arch of the aorta, or even beneath it, and if the other index finger is introduced through a gastrotomy opening into the stomach and projected upward, the two index fingers may be met. This is a valuable method in impacted foreign bodies. If the latter be of compact structure it may be fractured with bone forceps and the fragments extracted. Where esophagotomy has been done through edematous and infected tissues, no attempt at closure of the wound should be made; the wound should be permitted to heal by granulation. Prevent escape of fluids or food through the opening in the esophagus during the healing process by feeding the patient through a tube passed through the mouth or nose. It should be stressed that meticulous attention to [illegible] of utmost importance in these operations.

STRICTURES OF THE ESOPHAGUS

Non-malignant strictures of the esophagus may be treated by gradual dilatation with esophageal bougies passed per os. Thiosinamin injections are recommended as an aid to dilatation. The drug is credited with having a softening effect on scar tissue thus aiding the instrumental dilatation. The composition of the drug to be used is as follows: thiosinamine, [illegible] antipyrine, [illegible] water [illegible] cc. *The dose is [illegible] cc for an injection.* Usually ten doses are given.

Fig. 1109. Stricture of the esophagus, the result of drinking lye.

Direct Dilatation

Locate the position of the stricture (bougie, x-ray) (Fig. 1109). The principles underlying the procedure are the same as those of stricture of the urethra, *i.e.* commence with the smallest size of dilator and increase the size gradually. Remember that the stricture may be so small as not to permit even a filiform to pass. A thread swallowed is of immense value in such cases (Sondes [illegible]). Pass the bougie every second or third day. *Make sure that no aneurysm is responsible for the constriction before treatment is begun* (x-ray of chest, Wassermann).

Retrograde Dilatation

This is used in strictures of the lower portion of the esophagus. Do gastrostomy of proper size and locate it as near the cardia as possible. *Occasionally dilatation may be accomplished by the finger or various dilators of suitable size and shape.* For the primary introduction of a dilating agent, many devices are recommended.

[illegible]

This is very ingenious. It consists of swallowing a shot attached to a strong string to opening the stomach. The shotted end is pulled through the opening in the stomach to secure the return of a bougie or friction string. By this method, bougies of increasing size may be drawn upward and the stricture dilated.

Where the cardiac opening is nearly completely obliterated, the pathologic process may so encroach on the cardiac orifice that difficulty is experienced in locating it after opening the stomach. Finger or bougies may be used to accomplish the object. Under such conditions [illegible] the introduction of an endoscope passed from above along a string acting as a guide. According to Lange direct observation through an endoscope of the end of the opening may show the entrance of fluids swallowed. Sizes of bougies passed should be increased very gradually. Leave the bougie in position for about half an hour or longer if deemed advisable, increasing gradually the time for the larger sizes to about 24 to 48 hours. This is continued until a sound of about 30 [illegible] can be passed with ease. Later the intervals of bouginage are lengthened (say once every two to four weeks) and then one is satisfied that no recontraction threatens, once every six months or less frequently.

Forcible divulsion is mentioned only to be condemned. In long and narrow strictures one may find difficulty in maintaining the dilatation. Here one may insert into cervix hydrostatic tents and bougies, used by gynecologists to dilate the cervix uteri. These may be introduced into position under visual guidance and allowed to exercise continuous and gradually increasing pressure.

Abbe's Operation

The underlying principle of this procedure is division of the stricture by means of thread friction. Abbe has pointed out that the pouch formed at the esophagus above the stricture is often a hindrance to the passage of bougies. This difficulty is overcome by his operation.

Step 1. Do gastrotomy admitting two fingers.

Step 2. Pass a fine whalebone bougie from the mouth to the stomach upwards until it protrudes from the mouth. Tie two long stout threads of braided silk to the end of the bougie.

Step 3. Pull the bougie out through the stomach wound, leaving the two threads protruding from the mouth and stomach wounds. Attach the lower end of one thread to an eye at the point of a conical esophageal bougie (Tiffany). By pulling on the upper end of this thread, it is easy to bring the conical tip of the bougie into the stricture and render the stricture tense.

Step 4. Permit no gentle traction thus dilating the stricture with the bougie. Simultaneously pull the second string vigorously upward and downward with a sawing motion. The friction thus produced by the cord divides the stricture. When sufficient space is attained, the conical bougie passes upward as the continued friction wears away the stricture.

5. Pass and gently force the largest suitable bougie from below upward overcoming the possible tightness still persisting at the point of the divided stricture by manipulating the bougie past the point of resistance.

Step 6. Close the gastrotomy opening.

Comment. Follow up the operation by passing suitable sized bougies often, weekly or more often if required, for about a year or longer until the desired result is obtained. Begin with semi-solid and solid food feedings as soon as possible. Impress the patient with the importance of thorough follow-up treatment. The results of the operation, aided by proper after care, are good. The procedure is an old one and may find place in surgical practice in selected cases. The late Willy Meyer stated that Abbé's string method is the operation of choice and will in most cases be crowned with success.

Theodore Dunham has designed and improved an armamentarium which the late Willy Meyer lauded much. Dunham uses a fishline for cutting. While this is being done, the stomach, the gastrostomy opening, the mouth and pharynx are protected by means of special metal tubes through the lumen of which the fishline runs. At the point where the division is to be made, a metal olive on a wire-guide is held in place by the constricted part of the esophagus. The patient is anesthetized and the stomach washed out. The operation is done in a number of phases.

Meyer points out that any violent effort in the passage of sounds, etc., may lead to perforation with lethal mediastinitis. Do not divide or stretch the esophagus beyond No. 22 or 25 French gauge. Until this is accomplished, a silk thread always renewed in situ, the ends of which are fastened to the cheek and the abdominal wall by means of adhesive plaster. The thread must never be drawn too taut. Abbe's procedure should be divided into a number of stages beginning with the gastrostomy and then with the steps enumerated above. The results of Abbe's operation are "most gratifying and permanent. It has to be considered the standard operative procedure," says Willy Meyer. The daily descent of the food keeps the lumen patent. Of course, this operation can only be resorted to (a) if the stricture is permeable and (b) if a thread can be successfully passed from the mouth through the gastric fistula. Occasionally, an impermeable stricture may become permeable after a gastrostomy has been done. This is a result of cessation of the inflammation about the stricture. Lotheisen observes that permanent impermeable strictures are extremely rare. In the [illegible] cases he observed, it occurred only once. In that small percentage of cases and as last resort the following may be done: (a) Attempts at retrograde bouginage. (b) The formation of an antethoracic esophagus.

Caution. When instrumentation is performed, thiosinamine should not be administered, the reason being that the softening effect of the drug on scar tissue may affect the circumstances of the stomach.

ELECTROLYSIS

Wherever a dilator cannot be passed, electrolysis should be resorted to under supervision of the eye. A current of 3 milliamperes should be used and applied either to one side of the stricture (linear electrolysis) or all around it (circular electrolysis). Properly constructed electrodes should be selected (olive or ring shaped). The conducting wire should be properly insulated to avoid its coming in contact with the esophagus. Place the indifferent electrode on the

patient's chest. When the electrode is in position, turn on the current. Move the electrode gently in order to avoid its becoming adherent to the stricture. When the electrode has passed, either a larger one may be substituted or gentle dilatation with a soft bougie may follow. Dilatation is rendered more easy following electrolysis.

REBELLIOUS CASES

Though it rarely happens (1 out of 113 cases—Gabriel), all attempts to dilate the structured portion of the esophagus may fail. Recourse must then be had to one of the following procedures:

1. External Cervical Esophagostomy
2. Thoracic Esophagotomy
3. Cervical Esophagotomy
4. Esophagogastrostomy
5. Esophagectomy

ESOPHAGOSTOMY

This is employed to establish a fistulous opening into the esophagus, below an impassable, incurable constriction. It is used to supply food but has been entirely superseded by gastrostomy.

ESOPHAGOGASTROSTOMY

Esophagojejunogastrostomy—Roux's Operation

Step 1. Laparotomy. Pick out a mobile loop of jejunum. Ligate doubly and divide four or five of the vessels passing to the loop of the jejunum. Preserve the peripheral vascular arcades intact. Make sure that sufficient vascularization is assured through the vascular arcades of the selected portion of the jejunum near its caudal end. Clamp and divide the bowel at both ends of the selected segment.

Step 2. The caudal end of the isolated loop of the jejunum is now anastomosed with the stomach, near the lesser curvature.

Step 3. Create a subcutaneous tunnel beginning at the abdominal wound and extending to the suprasternal notch. The proximal (oral) end of the segmented loop of the jejunum is pulled through the tunnel just described and its upper end is sutured to the upper end of the tunnel with interrupted sutures. A stomach tube is now introduced through the segment of bowel implanted in the anterior chest wall, down into the stomach. Fix the stomach tube to the opening of the bowel at the cervical end.

Step 4. The continuity of the bowel is restored by an entero-enterostomy (suture or Murphy button—the latter is preferable).

If the patient survives this rather serious operation, the cervical portion of the esophagus may then be exposed and anastomosed to the upper end of the implanted subcutaneous segment of bowel.

Jianu Esophagoplasty

Step 1. Laparotomy. Deliver the greater curvature of the stomach.

Step 2. Divide the great omentum transversely below the gastro-epiploic vessels. Ligate and divide the right gastro-epiploic vessels; this renders the greater curvature of the stomach free from the omentum. It is nourished by the left gastro-epiploic vessels.

Step 3. Place a row of mattress sutures through both the anterior and posterior walls of the stomach along the lines A and B as indicated in Fig. 330.

Step 4. Make an incision along the lines A and B embracing both walls of the stomach. The flap of the stomach between the incised openings C and D is closed with two rows of continuous or interrupted sutures, as preferred. This converts the segment of the stomach into a closed tube open at its distal end C and continuous at the cardia at D. The left epiploic vessels

Fig. 330. Fig. 331. Fig. 332.

Fig. 330. Jianu's operation of esophagoplasty (after Pomeranz). After applying clamps as shown, an [illegible] section of the greater curvature of the stomach is separated as one limb in the [illegible].

Fig. 331. A tube thus results by closing the open greater wall and approximating the edges of the tube as shown.

Fig. 332. Insertion of final suture [illegible] into the wall of the stomach.

supply nourishment to this tube. A right-angled Connell suture inverts the marginal sutures of the tube (Figs. 330-332).

Step 5. Tunnel a subcutaneous tunnel from the abdominal wound upward and extending as in the Roux operation previously described, to about the level of the third costal cartilage. Pull the tube through the tunnel thus made and permit it to emerge through an opening in the skin overlying the sternum and suture its mucous membrane to the margins of the skin in the upper wound.

Step 6. Close the abdomen.

MEDIASTINAL ESOPHAGOGASTROSTOMY

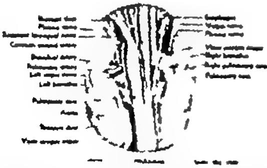
Historical Notes. William Levy (1898) suggested that carcinoma of the abdominal portion of the esophagus may be resected by the abdominal route and the cut end of the esophagus anastomosed with the fundus of the stomach. Kuttenberg some time later demonstrated that it was possible to anastomose the divided end of the esophagus with the wound in the fundus of the stomach. Levy noted that only 2 or 3 cm. of the esophagus may be removed by this method when it is resected. He also used the Murphy button. Pomeranz demonstrated, however, that 5 to 6 cm. of the esophagus might be excised [illegible]. Von Mikulicz turned up the left costal arch and incised the diaphragm upward for the purpose of obtaining better exposure. The diaphragm was sutured to the chest wall and the patient fed through a jejunostomy.

Ullmann (1920) successfully resected a carcinoma of the cardiac portion of the esophagus by a modified Mikulicz technic. Experimental and clinical researches in resecting carcinoma of the esophagus by transpleural esophagogastrostomy and by the abdomino-thoracic route have yielded the present day advanced methods of approach to the problem.

Bennett (1899) showed that it was possible to resect the cardiac portion of the esophagus transpleurally—transdiaphragmatic esophagogastrostomy. Others did some experimental work in this direction employing a U-shaped incision similar to that used in a thoracic gastrostomy. Wendel and Sauerbruch have employed this method. Brun recommended that one should first mobilize the stomach and duodenum and create a gastric fistula near the pylorus at the same time. The second act consists of a thoracotomy, eight to ten days later. The cardia is then freed, the diaphragm split and the stomach drawn up. The button is then inserted into the stomach and six to eight days later is pulled through the fistula into the stomach and removed.

Abdominal Esophagogastrostomy—Lilienthal's Operation

In carcinoma of the lower portion of the esophagus Lilienthal's operation is of distinct value (?).



Step 1. Thoracotomy is now replaced by posterior mediastinotomy (p. 984). Retract the pleura and lung carefully. Expose the lower end of the esophagus, upper surface of the diaphragm and esophageal opening in the diaphragm.

Step 2. Separate the esophagus by blunt dissection from the opening in the diaphragm. Enlarge the opening by an incision to the left sufficiently to permit the cardia and fundus of the stomach to be drawn into the field of operation.

Step 3. Divide the esophagus with the cautery knife between two clamps as low as possible above and below the neoplasm (Fig. 334). Protect the mediastinum by several large sponges wrung out of hot salt solution.

Step 4. Suture and invaginate the distal end of the stomach. Draw the fundus of the stomach upward sufficiently so that it will reach a distance temporarily about an inch above the remaining end of the esophagus.

Step 5. Make an incision into the stomach sufficiently large to allow of proper

implantation of the lower end of the esophagus. About one and a half inches below this incision a smaller incision is made into the stomach.

Step 6. Through the smaller opening in the stomach pass a needle bearing a double suture; bring it out through the upper larger opening in the stomach.

Fig. 335. Lilienthal esophagogastrostomy. [illegible] Courtesy of Dr. Lilienthal. Thoracic Surgery. W. B. Saunders Co.

The sutures are now cut. Four sutures are thus available. Rethread each of these with a needle and pass each through the wall of the esophagus at four equidistant points (Fig. 335).

Step 7. Make traction on these sutures and intussuscept the esophagus into the stomach; here it is anchored by two or three sutures which pass through the wall of the stomach and esophagus.

Step 8. Cut the traction sutures short and allow them to hang freely into the stomach. Close the smaller incision in the stomach (Fig. 336).

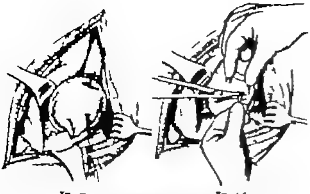


FIG. 1325. [illegible]
FIG. 1326. [illegible]

FIG. 1327. Traction sutures are now arranged in the wall of the esophagus. There are four strands.
FIG. 1328. The stomach has been drawn upon the esophagus which ... held through the stomach wall to feed into the passage of two through-and-through mattress stitches. The arrows the cutting of the traction sutures which draw back into the stomach. (Lilienthal: Thoracic Surgery, W. B. Saunders.)

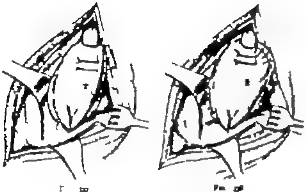


FIG. 1327. FIG. 1328.

FIG. 1327. Showing the mucous sutures closed with ... knots. The esophagus held within the gastric cavity by the two through-and-through mattress sutures.
FIG. 1328. The stomach wall has been invaginated by sutures bringing the peritoneal surfaces in contact and also in contact with the esophagus. Two or three sutures may be passed to anchor the stomach to the diaphragm. (Courtesy of Dr. Lilienthal: Thoracic Surgery, W. B. Saunders.)

Step 9. Invaginate the implanted gastro-esophageal area by a series of Cushing Lembert sutures (Fig. 1327).
Step ... Unite the stomach to the diaphragm where ... pierced—thus frustrating the development of diaphragmatic hernia (Fig. 1328).
Step 11. Close the abdomen. Drain.

The advantages of this procedure are the following:

Ample exposure during the operation.
Conservation of chest volume and lung capacity.
3. The continuation of the alimentary canal in as near an approach to the normal as seems possible without interposition of any foreign tissue between the stomach and intestine.
4. Location of the passage in a normal position—the posterior mediastinum.

Where time permits before the mediastinal operation ... undertaken ... gastrostomy is often of great value.

Kirschner's operation is an antethoracic esophagogastrostomy.

ESOPHAGECTOMY—RESECTION OF THE ESOPHAGUS

Torek has pointed out that in view of the fact that the esophagus ... never extirpated in toto, the usage of the term "esophagectomy" has become synonymous with "resection of the esophagus." The operation may entail removal of the involved segment of the esophagus in either its cervical, thoracic or abdominal portion. The cervical extirpation of the esophagus was first successfully performed by Czerny in 1877. Gluck and others have also reported successes. The abdominal portion of the esophagus was first successfully removed by Voelcker ... 1907. The credit for the first successful removal of the thoracic portion of the esophagus for carcinoma belongs to Franz Torek who in 1913 performed the operation. His patient lived for nearly 13 years following the operation and there was no recurrence. The mortality of cases of partial removal of the esophagus is necessarily high depending upon the degree of involvement and the experience and dexterity of the surgeon. The greatest mortality attends the removal of the thoracic portion of the esophagus.

Cervical Esophagectomy

In removing the affected portion of the esophagus, the surgeon frequently resorts to ... concomitant resection of the pharynx, larynx and trachea, depending upon the degree of involvement. A gastrostomy should be performed preceding the operation on the neck. Any standard method of gastrostomy may be performed. A minimum of ... cm. of the esophagus above and below the tumor should be excised. Torek admonishes that if the attachment of the esophagus to the trachea is ever so slightly firmer than the very loose normal connection, the larynx and trachea should be removed with the esophagus. As it is rare to find ... connective tissue between these two organs, the classic operation consists of resection of the larynx and trachea together with the esophagus. Dissection of the cervical lymph nodes should also be done. Commenting on postoperative irradiation and leaving involved lymph nodes behind, Torek points out that it is ... mistake to leave behind any affected nodes owing to the fact that radio-

therapy cannot compete with surgery despite the fact that lymphocytes are highly radiosensitive.

Anesthesia. Either infiltration block, tracheal insufflation or rectal anesthesia (Gwathmey) should be resorted to. In case the first is used, the third and fourth cervical nerves should be blocked on both sides; this is supplemented by regional infiltration. For the technic of blocking the cervical nerves see the chapter on Removal of the Thyroid Gland.

ACH CERVICAL ESOPHAGOPLASTY

Step ... Outline ... large triangular skin flap (Fig. 1329). Dissect ... free from the underlying tissues.
Step ... Turn the dissected flap upon itself to form ... tube (Fig. 1330) with the cutaneous surface directed inward.

FIG. 1329. FIG. 1330.

FIG. 1329. Cervical esophagoplasty: Ach operation. Outline of incision.
FIG. 1330. Ach operation. The flap ... dissected free from the underlying structures and turned upon itself to form ... tube ... [illegible] ... the cutaneous surface of the skin forms the inner lining of the tube. The free edges of the tube are sutured above and below to the pharynx and esophagus respectively. Observe that where the free edge of the tube meets the flap near its pedicle (right side of illustration) the tube ... open, to be closed subsequently.

Step 3. The tumor, of course, has been removed previously. The upper end of the tube thus formed is sutured to the upper and lower divided ends of the esophagus respectively. The continuity of the esophagus is thus restored except laterally where the edge of the flap is turned back upon the flap. Tampon the raw surface remaining.
Step 4. Two or three weeks later the defect is closed. The raw surface is covered by ... plastic procedure.

VON HACKER'S OPERATION

Step. Make ... longitudinal incision beginning at the hyoid bone and extending down to the sternum (Fig. 1331). To the longitudinal incision two transverse incisions are added, one at each end of the central cut. The longitudinal incision is made somewhat away from the median line.

Step 2. Bluntly separate the sternohyoid muscles from the larynx, thyroid gland and trachea.
Step 3. Divide the isthmus of the thyroid gland. Draw its lateral lobes to either side. Attend to careful hemostasis.
Step 4. Divide the constrictor muscles of the pharynx and the sternothyroid muscles close to their insertion at the thyroid.
Step 5. Dissect the trachea bluntly from the esophagus and at ... properly selected point divide it. If the trachea is not involved in the neoplasm it ... divided between the first and second tracheal rings. First make ... small incision externally and inject some cocaine into the mucosa of the trachea upward and downward. Novocain will not answer the purpose (Torek).
Step ... Insert ... few gut sutures in the anterior part of the trachea below the incision to prevent ... from slipping away after ... completely divided.

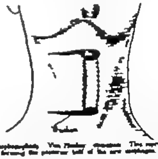


FIG. 1331. Cervical esophagoplasty: Von Hacker operation. The rectangle the flap of skin forming the posterior wall of the new esophagus.

Step 7. Insert ... tracheotomy cannula into the open trachea and cover ... with gauze. Tampon the upper stump of the trachea with gauze to prevent soiling of the wound.
Step 8. Select the site for dividing the esophagus which may be well down in the mediastinum. In one case Torek divided the esophagus 5 cm. below the sternal notch. Separate the esophagus from the vertebral column (this usually presents no difficulties).
Step 9. Divide the esophagus at ... safe distance from the tumor. Should the division be too low to permit of subsequent plastic repair, ligate the stump and let it slip back. Carry ... tampon into the mediastinum to prevent infection. If the esophagus is divided in the vicinity of the jugulum, attach ... temporarily to the lower edge of the wound in the skin or secure it with gut sutures.
Step 10. The involved area (larynx, pharynx, trachea and esophagus) ... now separated from the anterior surface of the spinal column. The thyrohyoid muscles are separated from the larynx and the other anterior attachments are divided. The epiglottis is usually allowed to remain.
Step ... Do ... block dissection of the cervical lymph nodes (which see). If no

plastic reconstruction is contemplated, proceed to close the pharynx with chromic catgut sutures. If [illegible] plastic on the esophagus is to be performed, it is left open and the sternohyoid muscles are not brought together in the midline but the divided ends of the thyrohyoid muscles may be sutured to the divided end of the sternothyroid on each side if this can be accomplished without tension. Otherwise this step is omitted.

Step 12. Suture the trachea to the skin.

Step 13. Insert [illegible] small rubber-dam and cigarette drain on each side extending down to the mediastinum.

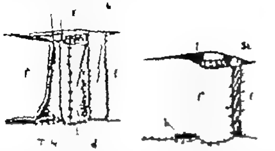


Fig. [illegible] Fig. [illegible]

Fig. [illegible] [illegible]

Step 14. Suture the two skin flaps together. Since the incision has been made [illegible] the suture line will be somewhat laterally. This skin bridge will form the posterior part of the new esophagus and [illegible] sutured above to the posterior wall of the pharynx and below to the posterior wall of the esophagus. Tampon the remaining opening at the pharynx with rubber-dam gauze.

Postoperative Care. Complications following this procedure are usually aspiration pneumonia, secondary hemorrhage and mediastinitis. These should be guarded against by proper measures.

When the tissues have healed satisfactorily, when no more discharges are present and granulation has proceeded to its optimum, reconstruction of the esophagus [illegible]

[illegible]

Step [illegible] Outline the longer flap [illegible] around tube by an incision which runs parallel to its original and at such [illegible] manner that when reflected [illegible] tube of sufficient caliber may be fashioned (Fig. [illegible]).

Step [illegible] Again divide the original suture line between the longer and shorter

flap and suture its medial edge to the newly reflected flap which is also sutured to the pharynx above and the esophagus below, in this manner completing the connection between the mouth and the esophagus.

Step 3. Thoroughly undermine and separate the remaining portions of the original flaps from the underlying tissues which were there in front of the new esophagus. Should this not be readily accomplished, the flap which was not used for making [illegible] new esophagus is drawn over and attached to the sternocleidomastoid muscle of the opposite side and the remaining defect covered by a Thiersch graft (Fig. [illegible]). The legends on the illustration explain the operative steps just outlined.

Since the nutrition of the newly shaped tube depends entirely upon recently established vascular connections supplying the spinal column, behind the pharynx

Fig. [illegible] The skin incision outlined [illegible] on the day preceding the operation of Torek [illegible] esophagectomy.

above and the esophagus below, sufficient time should elapse before the final step of the operation is undertaken.

The construction of the esophagus may also be accomplished by Roth's method (p. [illegible]).

TRANSPLEURAL ESOPHAGECTOMY

Torek's Operation

Step 1. On the day before the operation outline the course of the incision with silver nitrate (Fig. [illegible]). It must be recalled that the esophagus stands out more prominently on the right than on the left because it is covered by the right pleura [illegible] the aorta is not in the way. Nevertheless approach to the lower third of the esophagus from the right side is unfavorable because of the position of the liver.

Step 2. Perform [illegible] gastrostomy. With the patient on his side and supported by

sandbags [illegible] to the right side, the left arm is held upward and forward to displace the scapula from the line of incision; begin the incision in the [illegible] intercostal space and carry [illegible] over the entire length of that space. At its posterior end carry [illegible] vertically upward to the third interspace. Turn the skin flaps backward. Protect them with towels.

Step [illegible] Sever the fourth, fifth, sixth and seventh ribs. Open the pleura. Insert [illegible] rib spreader. Free the lung from adhesions and lay [illegible] around the front part of the mediastinal tissues. The esophagus appears as slight bulging in the parietal pleura to the side of the aorta. Divide the pleura and connective tissue covering the esophagus at some portion [illegible]

Fig. [illegible] The mediastinal pleura has been [illegible] the esophagus [illegible] The [illegible] beneath the aortic arch.

the latter [illegible] Lift the esophagus out of its bed. Draw [illegible] ward with [illegible] tape or to the side (Fig. [illegible]) while the dissection progresses upward to the thoracic aperture and down to the diaphragm. When the esophagus is severed high up the direction [illegible], of course, extend to the diaphragm. [illegible] Torek, "the extent of the dissection of the diaphragmatic end, we determine at what place below the tumor the esophagus is to be divided and allow about [illegible] cm. more for the invagination of the stump." The dissection is best done with the aid of [illegible] blunt instrument like Kocher's grooved sound or [illegible] long Mayo dissecting scissors which is inserted between the esophagus and the tissues lying over it. The fact

that some of the [illegible] branches entering the esophagus must be divided in the course of this procedure need not deter the surgeon.

It must ever be kept in mind that the esophagus may not be compared with the bowel as far as healing processes are concerned, the latter tending to prompt agglutination by reason of its peritoneal investiture [illegible] the esophagus does not possess. Hence even though an accurate apposition and [illegible] [illegible] secured, suppuration, pleurisy and mediastinitis are the usual sequels.

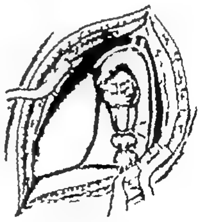


Fig. [illegible] [illegible] esophagectomy. Double ligation of the esophagus [illegible] For the lower ligature [illegible] the invagination of the stump [illegible]

The part of the esophagus lying beneath the aortic arch is the most difficult to dissect.

Step 4. At this point the esophagus must be freed from the left bronchus by blunt dissection. Avoid kinking the aortic arch for fear of sudden cardiac collapse. The finger or dissecting instrument is pushed by blunt dissection until the anterior border of the sternomastoid muscle is reached at the level of the upper thoracic aperture. Make an incision at this point through which the esophagus is later to be delivered.

Step 5. Ligate the esophagus doubly (Fig. [illegible]). Double

Little ... invaginate the stump and suture it over. When it is close to the diaphragm it may become necessary to use the cardiac end of the stomach to cover the stump should the latter not be long enough.

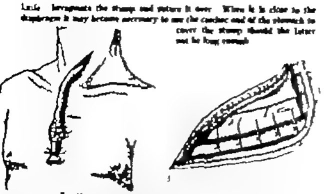


Fig. 1327 / Fig. 1328

Fig. 1327. [illegible] ... Carried by the [illegible] ... esophagectomy. Chest closed by ... pericostal sutures.

Step 6. Construct the distal end of the esophagus. Pull it up and out through the wound in the neck. The delivery of this end of the esophagus is facilitated by tying ... piece of tape around its end and guiding it to the surface (Fig. 1329).

Fig. 1329. Tube connecting lower end of esophagus with ... opening. The tube is held ... [illegible] ... (Torek.)

Step 7. Close the chest by bringing the ribs together by Sauerbruch's pericostal sutures, which pass either through the ribs or around them (Fig. 1328). The intrapulmonary pressure should be increased sufficiently during the last stages of the closure to keep the lung in contact with the chest wall. A certain degree of pneumothorax is of no moment.

Step 8. After thorough healing of the lower end of the esophagus has taken place the upper end of ... gastrostomy tube is inserted into it when nourishment is to be given to the patient. During the act of swallowing, slight pressure is exerted at one side of the tube to prevent leakage. The food when swallowed passes through the tube into

the stomach (Figs. 1329, 1330, 1331). The pleura is closed without drainage. Willy Meyer believes that drainage should always be instituted. Sauerbruch does not drain.

ESOPHAGEAL DIVERTICULAE

Diverticulae of the esophagus (Figs. 1332–1333) are classified according to their location:

Pharyngo-esophageal.
Below the upper opening of the esophagus.

In ... general way the upper (tracheal) curve is more liable to diverticulation, the lower (aortic) curve being relatively full.

Types

1. Pressure diverticula—due to pressure or pulsion from below within the esophagus.
2. Traction diverticula (inflammatory)—extrinsic factors causing traction.
3. Pressure-traction diverticula (combined factors).

Historical Notes. Ludlow and Lassorey described esophageal diverticula ... 1767. The condition was named by Cruveilhier in 1832.

Operations. About 1800 Sir Charles Bell thought of establishing ... fistula leading from the diverticulum to the surface. King (about 1840) thought of extirpation of these diverticular outpouchings. Kocher was first to perform the operation in 1892. The methods of procedure are:

Fig. 1330 / Fig. 1331

Fig. 1330. [illegible] ... the lower end.

Fig. 1331. Torek operation. [illegible]

1. Invagination	3. Extirpation in two stages
2. Diverticulopexy	4. Extirpation in one stage

Invagination

This operation was first proposed by Girard in 1896. In 1915 ... completed the idea of Girard in treating small diverticula by simple invagination. Those of larger size are invaginated by ... number of superimposed layers.

Diverticulopexy

Schmidt in 1911 ... of the idea that in order to prevent the entrance of food into the diverticulum, he would dissect the pouch free, and suture and fix

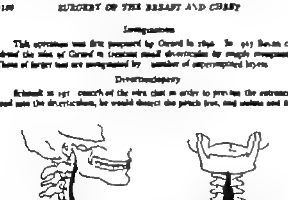


Fig. 1332 / Fig. 1333

Fig. 1332. Diverticulum of the esophagus, lateral view. Reconstructed by ... [illegible]
Fig. 1333. ... of the esophagus. Front view. Reconstructed from ... [illegible]

it in such ... manner that its fundus was placed on ... higher level than its orifice communicating with the pharynx.

Extirpation in Two Stages

Goldmann advised liberating the diverticulum at the first stage, then ligating it at its base, after which ... was permitted to remain in ... temporal area. The ... of an ... the pouch necroses and sloughs off ... fistula forms which closes spontaneously after ... few weeks. Lotheisen considers this procedure ... with modern surgical ... because of the ... which the ... cases. Murphy in 1906, ... the pouch and fixed it in ... position ... T... weeks later he removed the diverticulum.

Charles Mayo ... emphasized the importance of emptying the pouch previous to ... and using local anesthesia.

Bartlett, quoted by Mayo, suggested that ... the diverticulum at the upper

of the neck of the diverticulum is complete, the patient, under local anesthesia, ... instructed to close the lips and distend the mouth and pharynx with air ... distending the sac. The latter is identified not only by its location, but by its ... lighter color than the surrounding tissues.

Wullstein ... consists essentially of freeing and bringing out the sac at the first operation, and of ... subsequent excision of the lining at the second sitting, the mucous surfaces being left adherent to the skin and the planes of the neck being left undisturbed.

Extirpation in One Stage

The one-stage operation consists of isolating the sac, removing it and securely closing ... in the neck. Kocher's method ... operation, similar to dealing with an appendix stump. Further, divides the neck of the sac between clamps and deals ... with the stump after the ... method of closing the diverticulum ... the suture-line being vertical. Later ... which may be ... so as to form ... intestinal puckering. When ... the ... of the neck, ... unless great care be taken, he says, "traction on the sac may pull out ... portion of the normal pharyngeal wall which may be mistaken for ... the neck of the sac." In ... case recorded by Torek, ... the right lateral ... wall of the upper end of the esophagus was inadvertently removed ... the sac, and it was found necessary to suture the remaining portion and to do an end-to-end suture.

While the one-stage operation appealing to the surgical artistry, is (of course the ideal) procedure from the surgical and anatomic standpoint, and in favorable cases has much to commend it, the more tedious two-stage operation is to be recommended for safety's sake.

Gregoire operated on ... cases (up to 1924) in one stage, with 3 deaths the result of septic cellulitis of the neck or mediastinum. Gregoire states that with improved technic, casualties should be rarer. The procedure consists of exposure of the diverticulum, its isolation, extirpation, its division at the base and its ... and reinforcement by two layers of suture, to avoid the escape of liquid contents from the esophagus. The first row of sutures ... and ... superimposed by another row of sutures.

Gregoire's Operation

Step 1. Make an incision close to the anterior edge of the sternocleidomastoid muscle, which extends from the level of the hyoid bone almost to the clavicle (Fig. 1334). Divide the tissues.

Step 2. Draw the sternomastoid muscle outward and the laryngeal depressor muscles inward. If the omohyoid muscle ... is in the way, divide ...

Step 3. ... the fascia. The blunt retractor ... holds the sternomastoid muscle should displace the great vessels of the neck and the ... outward. The ... muscle ... may be seen covering the bodies of the vertebrae.

Step 4. Identify the inferior thyroid artery ... it crosses the field of operation emerging from behind the common carotid artery. It may be saved but Lilienthal believes ... best to divide it between two ligatures.

Step 5. Identify the esophagus by passing ... full-sized stomach tube through the

[illegible]

needle carrying No. [illegible] chromicized catgut (Fig. 1537D). Excise the neck of the sac close to the pharynx (Fig. 1537E).

Step 6. Cauterize the stump [illegible] pure phenol (Fig. 1537F). Place mattress sutures of No. [illegible] chromicized catgut one above and one below the stump (Fig. 1537GH). Penetrate only the submucous coat of the pharynx. Bring together with sutures over the lengthened area, the cricopharyngeus and the inferior constrictor muscles. If the pouch originates at Killian [illegible] slit, join the cricopharyngeus and the upper circular fibers of the esophagus.

Step 7. Close the incision in the neck in layers. Place [illegible] small rubber tissue or cell-silk drain under the deep fascia (Fig. 1537I).

Shallow [illegible]

"1. In [illegible] series of 96 pharyngeal diverticula, all operated on by the one stage method, there were [illegible] deaths.

"2. Seventy four patients had complete recovery.

3. None of the cases was complicated by mediastinitis.

4. None of the cases required postoperative esophageal dilatation.

5. The use of the esophagoscope prevents angulation, stenosis, and stricture of the esophagus.

"6. Hoarseness is often [illegible] chief complaint.

"7. There are 3 areas of the pharynx from which diverticula may arise.

"8. The one stage method of operation is the reasonable method of treatment of pulsion diverticula of the pharynx.

9. The results depend upon rational surgical procedure and accurate approximation of tissues.

10. Meyerding[illegible] believes that there is no need for operations in two stages. He has operated upon [illegible] 5 cases and has "never had any difficulty in obtaining healing by first intention.

[illegible] Turek [illegible] says "Thirty years ago the mortality was very high with the one stage procedure, but in the last 5 years, [illegible] cases have been recorded with [illegible] mortality of only [illegible]

SURGICAL TREATMENT OF MEGA-ESOPHAGUS

The surgical treatment of mega-esophagus is aimed toward the removal of the obstacle at the abdominal part of the tube caused by anatomico-pathologic changes in the organ. Anatomic and physiologic studies have demonstrated that the obstacle here is localized in the subdiaphragmatic part and that relief may be obtained by destruction of the sphincteric apparatus at this site.

The surgical methods in use for the treatment of mega-esophagus may be divided into the bloodless and [illegible]

The bloodless methods include slow and rapid dilatation. Slow dilatation is accomplished in the usual way by successive introduction of sounds of varying diameters. The rapid dilatation is accomplished by the introduction of rubber bags which are then distended by hydrostatic pressure (method of Gottstein and Plummer) by air distention (Plaschkolte [illegible] method) or by Starck [illegible] expansible metallic apparatus.

Surg. Gynec. and Obst., [illegible] [illegible]
Am. Surg., Vol. [illegible] [illegible]

"The rapid dilatation method is considered to give better permanent results than the slow method. It is the most benign of all methods and is reported to give fairly good permanent results in at least 75 per cent of cases. The only danger is that of rupture of the esophagus with resulting mediastinitis and fatal peritonitis. This danger occurs with both the hydrostatic and metallic dilators but in the latter in addition, there is [illegible] greater possibility of injury to the lung of the esophagus. (Tsoucaridos and Botella.)

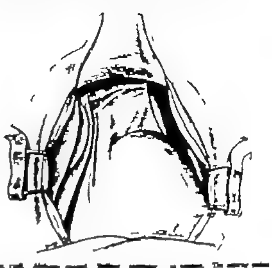


Fig. [illegible] [illegible]. The anterior surface of the dome of the stomach [illegible] [illegible] (Tsoucaridos and Botella.)

The additional surgical methods include intragastric dilatation, Heller [illegible] cardiolysis, esophago-cardioplasty by the abdominal route, Heyrovsky esophago-gastro-anastomosis and trans-thoracic-abdominal methods of esophagogastrostomy.

The intragastric dilatation method was introduced by Mikulicz in 1904 and the operation has been done by [illegible] number of surgeons. It should, however, be regarded as an exceptional method when direct dilatation [illegible] impossible.

Heller's Cardiolysis

This operation was introduced by Heller in 1913 and he gave it the name of extramucosal cardioplasty. The technic is as follows.

Step 1. Make [illegible] long incision parallel to the left costal border close to the xiphoid appendix, all planes being divided. The cartilages of the 7th, 8th and 9th ribs are uncovered and they are sectioned, care being taken at the 7th rib not to injure the pericardium. This gives access to the cardia. Some prefer [illegible] median xipho-abdominal incision, as giving an easier cardial approach.

Step 2. Following opening of the abdomen, Balfour [illegible] separator is applied and the retraction gives ample view of the operative field (Fig. 1538). The left lobe of the liver which covers the cardia is displaced by sectioning the triangular ligament and, if necessary, the left part of the coronary ligament. This uncovers the abdominal part of the esophagus. The liver [illegible] held back by retractor.

Fig. 1539. Esophagocardiotuberosity branch. [illegible] Anterior esophageal [illegible] cardial branch [illegible] tuberosity [illegible] left gastric artery. Reproduced from one [illegible] the specimens [illegible] the author [illegible] [illegible] Tsoucaridos and Botella.

Step 3. The stomach is seized between the fingers and pulled in [illegible] caudo-caudal sense, drawing the cardio-esophageal segment downward. Examine the region for any periesophageal inflammation. Search carefully for the gastrohepatic branch of the pneumogastric nerve and [illegible] verify the position of the inferior diaphragmatic arteries, as well as the esophago-cardiotuberosity artery. The peritoneum is incised vertically avoiding nerves and vessels (Fig. 1539).

Step 4. The peritoneal folds are dissected so as to completely expose all of the abdominal esophagus which is then mobilized (Fig. 1540). All the tissue bands which connect the esophagus to the diaphragm are cut away and the posterior surface of the esophagus exposed. A piece of gauze is wound around the esophagus which facilitates traction. In this way the dilated part of the organ and the stricture abdominal part are brought into the operative field.

5. This is the most delicate part of the operation. It consists of sectioning the muscular layers of the esophagus by [illegible] vertical incision which begins [illegible] to 3 cm. above the strictured zone and terminates from [illegible] to [illegible] cm.

below. One incision [illegible] made in the anterior wall and another identical one in the posterior wall. These incisions should not include the mucosa. Following these incisions, the muscular fibers retract and the abdominal esophagus expands immediately.

Step 6. Restoration of displaced organs and closure of the abdominal cavity without drainage completes the operation.

Fig. 1540. The peritoneum [illegible] dissected permitting [illegible] clear view of the pillars and esophageal [illegible] of the diaphragm, the abdominal segment of the esophagus and the anterior pneumogastric nerve [illegible]. The stomach [illegible] held [illegible] downward position by an assistant. The dotted line shows Heller's incision. ([illegible] Tsoucaridos and Botella.)

Heyrovsky Esophago-Gastroanastomosis

This operation was practiced for the first time by Heyrovsky in 1913. The technic [illegible] as follows.

Steps [illegible] to 4. The preliminary stages of this method are the same as those in Heller's operation up to the time when the exposed esophagus is [illegible] in [illegible] fold of gauze and pulled into the operative field (Fig. [illegible]).

Step 5. The lower part of the thoracic esophagus is pulled down and [illegible] complete view of the dilated part obtained. The essential procedure in this operation is to make an anastomosis between the esophagus and stomach, an opening at the dome of the stomach about 3 to [illegible] cm. being made. The stomach is

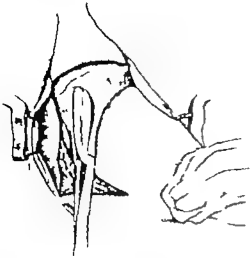


Fig. [illegible]. [illegible] After the abdominal segment of the esophagus [illegible] (Vasconcelos and Batalha.)

Fig. [illegible]. [illegible] of the superficial planes. (Vasconcelos and Batalha.)

held by [illegible] gauze compress and kept maintained under traction by an assistant. The esophagus is similarly held under traction by another assistant. The superior part of the stenotic esophagus is approximated to the dome of the stomach.

Step 6. The anastomosis is made at selected points in both structures. Supporting sutures are first placed at the extremities to maintain the position while the anastomosis is being made. Then the esophagus and stomach are

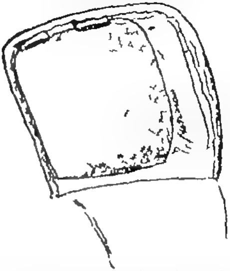


Fig. [illegible]. [illegible] (Vasconcelos and Batalha.)

joined by [illegible] sutures, beginning posteriorly. Proceed to finish the suturing, beginning the suture by closing the anterior segment.

Step 7. The stay sutures are kept in place to prevent re-entrance of the stomach into the thorax through the diaphragmatic hiatus. The gauze strips are removed and the viscera restored to place. Opinions vary regarding the necessity for drainage.

Thoraco-Abdominal Approach to the Esophagus. Vasconcelos and Batalha Technic

Several methods of thoraco-abdominal approach to the esophagus have been described in the literature, that through posterior [illegible] being preferred

for surgical reasons. The technic of the method devised by Vasconcelos and Batalha follows:

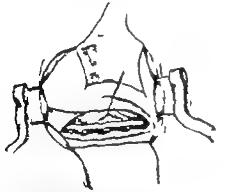


Fig. [illegible]. [illegible] (Vasconcelos and Batalha.)

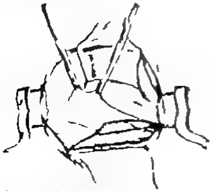


Fig. [illegible]. Diaphragm [illegible] the diaphragmatic planes. The dots show the line of section of the diaphragm. ([illegible] and Batalha.)

Step [illegible]. Place the patient on the right side with [illegible] cushion under the dorso-lumbar region. The left arm is kept elevated. Make [illegible] U-shaped incision [illegible]

with unequal limbs. The medial limb of the incision commences at the level of the eighth rib and extends to the twelfth (Fig. [illegible]). The second vertical

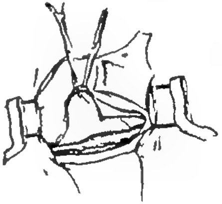


Fig. [illegible]. The diaphragm [illegible] the dome of the stomach [illegible] through the hiatus. ([illegible] and Batalha.)

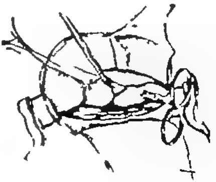


Fig. [illegible]. The esophagus and [illegible] are approximated and joined. [illegible]

limb ascends along the posterior axillary line to the eighth rib. The [illegible] are carried to the skeletal plane and the flap raised, uncovering

Step [illegible] Resect the twelfth rib, section the tenth and eleventh ribs through their extremities (Fig. 363). Resect the intercostal muscles. Expose the parietal pleura and fundus of the costodiaphragmatic space. Detach the pleura from its connections with the vertebral column and aorta. This gives easy access to the mediastinum. The most delicate step of the operation is the detachment of the diaphragmatic pleura which adheres more or less strongly to the muscular layers.

Step 3. Detachment of the mediastinal pleura exposes the sympathetic-thoracic ganglionary chain, the aorta and the thoracic esophagus (Fig. 364). The splanchnics are seen clearly and injury to them should be avoided. The

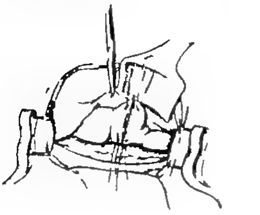


Fig. 368. [illegible] the [illegible] are seen at the angle of the [illegible]. (Vassamides and [illegible])

diaphragmatic hiatus is isolated and the phreno-esophageal membrane being partly destroyed, the diaphragm is sectioned (Fig. 365).

Step 4. Following section of the diaphragm, a carefully selected portion of the dome of the stomach is seen directly and is drawn into the thorax (Fig. 366). The branches of the peri-esophageal plexus are carefully isolated and the branches of the esophago-cardio-tuberitary artery are ligated.

Step 5. The esophagus is approximated to the stomach (esophagogastroanastomosis) and is being held by stay sutures. Into the esophagogastroanastomosis in two planes of continuous suture is executed (Figs. 367, 368).

Step 6. Suture the diaphragmatic breach so as to avoid transdiaphragmatic hernia of the stomach. Drain the mediastinum with iodoform gauze. Closure of the musculo-cutaneous planes concludes the operation.

CHAPTER 31

SURGERY OF THE HEART AND PERICARDIUM

PERICARDIUM

Historical Notes. Riolanus, in 1649, was the first to advocate paracentesis of the pericardium. Trephining the sternum was practiced by Skielderup (1798) and by Malle (1827). Dieulafoy recommended aspiration. Trousseau [illegible] sept cases by [illegible]. Sir Charles Ballance, in his Bradshaw Lecture on the surgery of the heart in 1920, asserted that the operation of paracentesis pericardii should be banished from surgical practice.

Anatomic Considerations (Fig. 369). The Pericardium. The pericardium is the serous sac which encloses the heart and the proximal portions of the great

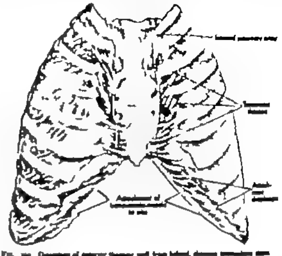


Fig. 369. [illegible] of anterior thoracic wall from behind, showing [illegible] and [illegible]

vessels. Like other serous sacs, it consists of two layers, one of which, the visceral layer, closely invests the heart and at its base becomes continuous with the parietal layer within which [illegible] invaginated.

The visceral layer, sometimes termed the epicardium, is so exceedingly thin [illegible], and [illegible] throughout the greater part of its extent so closely adherent to the outer surface of the heart that any attempt to detach it results in injury to the superficial layers of the heart musculature. Over the right side and the anterior surface of the ventricular portion of the heart, however, a certain amount of fat occurs between the muscular tissue and the epicardium even in thin persons.

The parietal layer, much stronger than the visceral, forms a somewhat conical sac, the base of which rests upon and is attached to the diaphragm, while its apex surrounds the roots of the great vessels. Notwithstanding its greater size, no cavity exists normally between this and the visceral layer, the two being in contact throughout, except below where towards the periphery of the base of the parietal cone a slight space occurs that is normally occupied by a quantity of pericardial fluid (liquor pericardii).

At the sides, and to a considerable extent on its anterior surface, the parietal layer of the pericardium is fused to or in close contact with the adjacent pleurae. At the upper part of its anterior surface where it covers the aorta it is free from such contact, and over a triangular area near the base of the cone the anterior surface rests upon the posterior surface of the lower part of the sternum, to which it is attached by some loose areolar tissue. Posteriorly it is free from the pleurae to a considerable extent, that portion of it which covers the posterior surface of the left auricle resting upon the esophagus and the thoracic aorta. The base of the cone is firmly united to the upper surface of the diaphragm throughout its entire extent, the area of attachment corresponding to the anterior and [illegible] portion of the left lobe of the central tendon.

The parietal layer of the pericardium is in relation with an external fibrous layer which extends beyond the serous investment of the roots of the great vessels, blends with their outer coats and is directly continuous with the deep cervical fascia, thus connecting the pericardium with two respiratory organs, the diaphragm below and the cervical muscles (sternohyoid) above. When these act conjointly as in full inspiration they render the pericardium tense and resisting, and [illegible] the pressure upon the heart by the inflated lungs.

The Heart. The outlines of the heart are as follows. A line drawn convexly outwards from the third to the sixth right chondrosternal junctions will represent the right border. A line from the sixth right chondro-sternal junction to a point in the fifth left interspace, three and a half inches from the mesial plane, corresponds to the lower border, while a line from the last point to the second left interspace, half an inch from the sternal margin, marks out the left border. The anterior surface of the heart mainly consists of the right ventricle, a portion of the right auricle, and about half an inch of the left ventricle. Of these the right ventricle is the part most liable to injury from punctured wounds. Owing to the thinness of its wall, wounds of the right auricle are almost invariably fatal. The right auricle receives the superior vena cava, the inferior vena cava, and the cardiac veins. It opens into the right ventricle by the tricuspid orifice which is guarded by the valve of the same name. Springing from the conus arteriosus of the right ventricle is the pulmonary artery; its semilunar valves prevent regurgitation of blood from the artery into the ventricle. The four pulmonary veins terminate in the left auricle from which the blood enters the left ventricle through the mitral orifice which is guarded by the mitral or bicuspid valve. The aorta arises from the vestibule of the left ventricle. Its valve, like that of the pulmonary artery, consists of three semilunar cusps.

The heart is supplied by the coronary branches of the ascending aorta. The right coronary occupies the right auriculo-ventricular groove and sends a descending branch along the posterior inter-ventricular sulcus. The left coronary artery runs in the left auriculo-ventricular furrow and gives off a descending branch which lies in the anterior inter-ventricular groove.

PARACENTESIS PERICARDII

Sites recommended for paracentesis of the pericardium are: Third intercostal (Schuh and Sharp), fourth intercostal space (Karawaeff, Pongeff), fifth intercostal space (Stevens, Dieulafoy, Rosenbach), sixth intercostal space (Delorme and Mignon, Voinitch-Sianoschensky), seventh intercostal space (Bäckmann, Reiner), and the left costo-xiphoid notch close to the ensiform cartilage (Marfan, Roberts and Abraham). Marfan's subxiphoid puncture is an approach. Important facts to remember in doing a pericardial paracentesis

are: Avoid injury to the (a) pleura, (b) the heart and (c) the internal mammary artery (Figs. 370–371, 372).

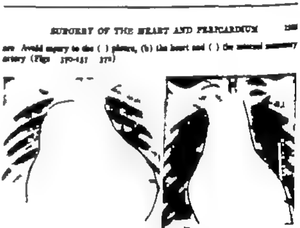


Fig. 370 Fig. 371

Fig. 370. Increased pericardial effusion.

Fig. 371. Pericardial effusion after pneumopericardium.

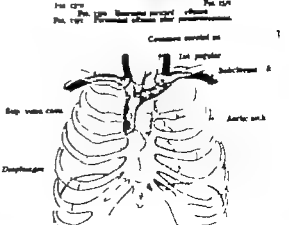


Fig. 372. Relations of the heart and blood vessels to the anterior wall of the chest.

Voinitch-Sianoschensky made an exhaustive study to determine the [illegible] pericardial area not covered by the pleura in a large number of normal subjects.

The long axis of this space which is the resultant site of greatest safety extends from the seventh left chondrosternal articulation vertically upward to the level of the lower border of the fifth chondrosternal articulation. This line lies clearly behind the sternum but touches upon the sixth space just at the sternal margin (Fig. 373C).

Technic of Pericardiocentesis. This procedure is indicated both as means of diagnosis and of treatment. If for diagnosis, use a long, aspirating needle. If for treatment, a trocar should be employed. Withdraw the fluid slowly. If pulmonary or cardiac distress supervenes, stop for a while until the condition of the patient improves. It is not advisable nor necessary to withdraw the fluid completely.

Fig. 373. [illegible] for puncturing the pericardium. [illegible] Parasternal puncture [illegible] Lateral puncture [illegible] C. Puncture [illegible] of the sixth space [illegible] D. Marfan [illegible] puncture.

The usual site for introducing the aspirating needle is the fourth, fifth, or sixth intercostal space about an inch to the left of the sternum. The last named is the safest point to avoid injury to the important structures named above.

Marfan Method

Place the patient in a semi-sitting position. Introduce a spinal-puncture needle in the median immediately below the xiphoid cartilage (Figs. 373D, 37[illegible]) and pass the needle obliquely from below upward along the posterior surface of the sternum for about [illegible] cm; thence somewhat obliquely backward into the gap in the sternal insertion of the diaphragm, thus penetrating the pericardium at its base.

It will thus be seen that in this method the pleura and internal mammary artery are definitely avoided. According to Kirchmann, the depth to which the needle ought to penetrate is approximately [illegible] cm. ([illegible] in.) in patients less than five years of age; [illegible] cm. ([illegible] in.) in those from five to ten years; 5 to 6 cm. ([illegible] in.) in those from ten to fifteen years; 6 cm. ([illegible] in.) in individuals more than fifteen years of age. In the adult the depth to which it is necessary to penetrate will vary a little according to the shape of the thorax, the more or less marked concavity of the diaphragm, and the degree of distention of the pericardial sac. Practically, however, as the puncture will always be made with a vacuum in the aspirating apparatus, the needle will be pushed in until the liquid begins to flow. This method of puncture should not be used when the [illegible] is [illegible] or when there is much abdominal distention.

[illegible] "La [illegible] de [illegible] [illegible] [illegible]. La ponction [illegible] de Marfan." Thèse de Paris, [illegible].

Lateral Paracentesis

Here the puncture is made about four fingers' breadth from the sternum (Fig. 375). Make a vertical incision about half an inch in length over the intercostal space selected. Push the needle inward obliquely almost parallel to the deep surface of the thoracic wall (Lépine). Never insert the needle deeper than about an inch from the surface (Terrier and Raymond). If no fluid issues at that depth it is best to abandon further efforts and do a pericardiotomy (p. [illegible]). A sharp, quick, dexterous thrust and experience are required to skillfully overcome the resistance offered by the pericardium, particularly when it is thickened or distended with fluid. Be careful not to permit the end of the trocar to

Fig. 374

Fig. 375

Fig. 374. Marfan [illegible] puncture of the pericardium.

Fig. 375. Lateral puncture of the pericardium.

irritate the heart (proper position of the point of the cannula). When the flow is scanty or lessened bring the patient into a sitting position.

Parasternal Paracentesis

This is more difficult to do than the preceding (Fig. 376). Make a transverse incision in the skin about an inch long, at the inner end of the sixth left intercostal space exposing clearly the border of the sternum. Guide the trocar to the wall of the chest, direct it obliquely inward behind the sternum for about three-quarters of an inch, then point it inward and downward until the pericardium is opened.

Trans-sternal Paracentesis

ROTTER'S PROCEDURE

Step 1. A vertical median incision is made 5 cm. in length the center of which is opposite the fifth costal cartilage.

Step [illegible]. The surface of the sternum is exposed with a raspatory and perforated (Fig. 377) with a trephine, flat drill or cylindro-spherical burr of between 16 and 20 mm.

Step 3. Irrigate the wound and grasp the pericardium with closed forceps at the time of puncture.

Step 4. Suture and tampon the wound. If drainage is indicated a soft split rubber tube is inserted after opening the pericardium.

PERICARDIOTOMY

Duval-Barasty Extrapleural Pericardiotomy

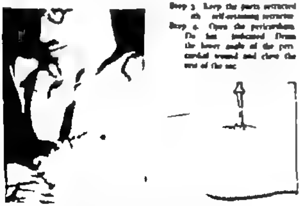
The essential steps of the operation are as follows (Figs. 378-379):

Step [illegible]. Free the ensiform cartilage and remove it through a median incision.

Step [illegible]. Split the sternum with a rotary saw to the third intercostal space. Divide it across.

Step 3. Keep the parts retracted with a self-retaining retractor.

Step 4. Open the pericardium. Drain [illegible] indicated. [illegible] the lower angle of the pericardial wound and close the rest of the sac.



F[illegible] 37[illegible] Parasternal puncture of the pericardium.

[illegible]

Delorme and Mignon Method

Step [illegible]. Make a vertical incision about [illegible] cm. from the left border of the sternum in a curved direction and extending from the lower border of the seventh to the upper border of the fourth costal cartilage.

Step [illegible]. Resect a portion of the fifth and sixth costal cartilages.

Step [illegible]. Detach the insertions of the triangularis sterni muscle. Push away the loose cellular tissue from the pericardium.

Step [illegible]. Displace the mammary vessels and open the pericardium.

Comment. Von Kaulsberg's method consists of resecting the fourth left costal cartilage.

Ollier's Operation

This is essentially a subperiosteal resection of the left fifth costal cartilage.

Step [illegible]. Make an incision about three inches in length beginning at the midline of the sternum and extending outward over the fifth cartilage. The cartilage is divided with a knife close to the sternum. Introduce a Doyen rib elevator clearing the deep surface, raise and turn it outward. Remove the cartilage

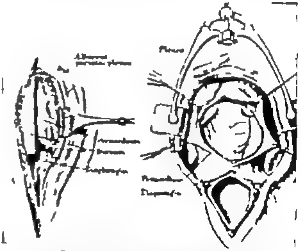


Fig. 378 Fig. 379

Figs. 378-379. Extrapleural pericardiotomy by the Duval-Barasty [illegible]

at its articulation. Retract the lips of the incision upward and downward exposing the fourth and fifth intercostal spaces.

Step [illegible]. An incision in the intercostal tissues is made parallel with and close to the border of the sternum. Detach the triangularis sterni muscle and push it outward.

Step 3. The pleural cul-de-sac adheres only slightly to the pericardium but firmly to the muscle (Delorme and Mignon). Figure 3[illegible] shows the attachments of the triangularis sterni muscle to the posterior surface of the sternum. The periosteal separator should therefore be introduced

the sternal border parallel to the deep aspect of the bone, and the tendinous insertions and the muscle detached by working the instrument upward and downward.

Step 4. Introduce finger through the opening made with the director, retracting the tissues and exposing the pericardium.

Rehn Durante Method of Pericardiotomy

Step 1. Make an incision between the ribs extending from the sternum externally. In case of injury of the chest, avoid the wound inflicted by the missile or knife. The incision is usually made in the fifth intercostal space.

Step 2. With rib spreaders, separate the ribs forcibly.

Step 3. Open the pleura (Fig. 380).

Step 4. Grasp the lung with appropriate forceps and displace outward. If there is not sufficient room for the operative procedure, one should resort to resection of one or more ribs, or if need be, partial resection of the sternum. Where one finds that the approach to heart with greater difficulties, longitudinal median incision through the sternum should be made and the approach to the pericardium sought. In such instances, the incision should begin at the upper border of the third rib and end at the upper border of the sixth. The costal cartilages of the respective ribs are divided close to the sternum and the flap, consisting of bone and soft structures, is displaced upward or downward according to indications. Avoid injury to the internal mammary artery.

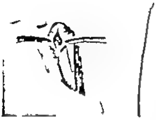


Fig. 380. Rehn method of pericardiotomy.

Step 5. Where there is no emergency existing one may proceed cautiously and carefully, avoiding injury to the pleura by working close to the border of the sternum and carefully separating the ribs at the sternal junction. Separate the pleura from the pericardium with great care. Open the pericardium by means of a long or transverse incision.

Bunnie Operation

Step 1. Make an incision down to the bone to the left, from the mid-line of the sternum at the level of, and following the line of, the sixth costal cartilage. If necessary the incision may extend to the left mammary line.

Step 2. Separate the perichondrium and all the soft parts from the sixth costal cartilage. Excise the cartilage.

Step 3. Ligate the mammary vessels in the triangular muscle of the sternum and divide its tendinous insertion into the sternum.

Step 4. The exposed pericardium can now be drained and the operation ended if drainage alone is needed.

Step 5. If more room is needed, make an incision from the horizontal cut upward in the midsternal line to the point desired, usually the level of the second rib.

Step 6. Separate the periosteum and soft structures from the sternum to the left of the median line. Divide the fifth, fourth and third left costal cartilages at their insertion into the sternum.

Step 7. Push the exposed margin of the pleura upward through the horizontal incision and gradually separate it from the fifth and even the fourth and third costal cartilages.

Step 8. After separating the flap from the pleura, fracture or divide the costal cartilages in the flap at their costal insertion.

Step 9. Split the pericardium along the sternal margin and laterally along the fifth interspace. This gives access to the heart from the auricle to the apex of the ventricles.

Step 10. If more room is desired, a sufficient portion of the sternum may be excised with bone forceps or by means of a rongeur.

Step 11. Wipe away any blood clots in the open pericardium. Suture the existing cardiac wounds with catgut or silk, care being taken not to suture any coronary artery.

Step 12. Close the pericardial wound with or without drainage.

Step 13. Suture or drain any pleural wounds which may be present. Don't waste time by trying to remove blood thoroughly from the pleural cavity.

CARDIOLYSIS

Decortication of the heart was first recommended by Delorme in 1898. Rehn performed the operation in a case of adhesive pericarditis. In 1902, Brauer suggested an operation to which the name cardiolysis is applied, its object being to counteract the damage resulting from adhesive mediastinopericarditis. In substance the principles underlying the procedure are:

Delorme's Operation

Step 1. Expose the heart by temporary resection of the thoracic wall.

Step 2. Open the pericardium.

Step 3. Manually break down the adhesions existing between the pericardium and heart.

Brauer's Operation

This operation is not designed to free the adhesions from the heart but to render them innocuous. This is accomplished by excision of ribs and cartilages, even a portion of the sternum to an extent called for by the existing condition (three ribs or more if necessary). After this the cutaneous flap is replaced. A suitable protection should be worn later over the site of the operation (Fig. 381).

The reader is referred to Schmieden's thorough work on the subject. In brief, his procedure is as follows:

Step 1. Make a flap extending over the third to the sixth ribs inclusive (on the left side).

Step 2. Lift up the flap. Cut the costal cartilages (left) close to the sternum. Resect considerable portions of ribs subperiosteally depending upon the requirements of the case.

Step 3. Push back the soft tissues. Smooth the sternal margin with rongeurs.

Step 4. Carefully dissect out the scar-tissue surrounding the heart. Avoid opening the pleura.

Comments. Usually only the left heart needs decortication. If the left phrenic nerve is found imbedded in scar tissue it may be resected. Free the heart from all restraining bands (diaphragm, etc.). Work carefully on the right side because the wall of the heart is weaker here. Never attempt decortication of the auricles (Schmieden). Human results

Fig. 381. Scheme of cardiolysis.

that an extrapleural resection of ribs (extrapericardial thoracolysis) is an excellent method to afford freedom of movement to the heart. It is a simple and successful procedure provided, however, the cases are well selected.

CONTUSIONS OF THE HEART

Claude S. Beck described the "steering-wheel" type of accident producing contusion of the heart which is driven against the spinal column (Fig. 382). The usual symptoms complained of are dyspnea and weakness. Circulatory collapse may develop. In gross injury of the heart, rupture of the auricles and ventricles may take place.

PERICARDIECTOMY

In the Treatment of the Pick Syndrome

by Claude S. Beck revealed that the essential factor in the production of Pick's disease is fibrosis and contracture of the parietal pericardium or ..., or both, forming a casing of scar which compresses the heart and

presumably obstructs its filling, interfering with cardiac motion. Connective adhesions between the epicardium and the parietal pericardium are not sufficient in themselves to produce polyserositis.

Coincidental with the development and contracture of scar tissue about the heart, the clinical manifestations of the Pick syndrome in the order of their appearance are: (a) rise in the venous pressure; (b) ascites and the development of fibrous cirrhosis on the liver; (c) hydrothorax; and (d) pulmonary and subcutaneous edema. Together with the observations reported, there occurred general weakness and listlessness, small and rapid pulse, cyanosis and decrease in the minute volume output of the heart. It was shown roentgenographically that the heart and pericardium actually decreased in size and assumed a globular shape as the syndrome developed. After the pericardium was resected, the heart assumed its previous size and shape. But subsequently the compression effect of the tight scar on the heart can be demonstrated fluoroscopically by the limitation of the systolic and diastolic movements of the heart.

Fig. 382. The "steering wheel" type of accident producing contusion of the heart. The heart is driven against the spine ... dyspnea and weakness are the usual symptoms. In the more severe cases circulatory collapse may develop. Auricles and ventricles may be ruptured. (Courtesy of Dr. Claude S. Beck.)

The shift of the electrical axis of the heart with a change of position was of slight diagnostic significance in the experiments. It is of greater diagnostic significance in the determination of extrapericardial adhesions.

In tapping the ventricles for specimens of blood for cardiac output determinations, the aspirating needle encountered a definite resistance if the parietal pericardium was thickened and scarred. This may be useful in diagnostic aid in obscure cases.

On the basis of experiment it was found that the venous pressure was the most reliable index to the development of this condition. A rise in the venous

pressure was always noted before fluid or [illegible] in the chest could be demonstrated.

The cavity of [illegible] scar can almost always be resected. Usually [illegible] plane of cleavage can be found and separation can be carried out by blunt dissection.

Claude S. Beck Operation

Place the patient in [illegible] position on the operating table [illegible] administer ether vapor anesthesia.

Step [illegible] Make an incision beginning at the costal margin in the midclavicular line on the left, curving medially and superiorly to the midsternum, follow

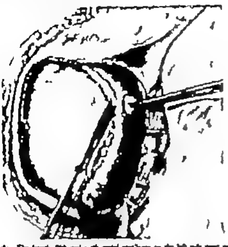


Fig. [illegible]. The fourth, fifth and sixth costal cartilages on the left side were resected and the sternum was partially resected. The pleural sac on the left was dissected from the pericardium. (Courtesy of Dr. Claude S. Beck.)

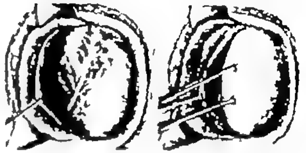
the midsternum for [illegible] inches and curve laterally to the midclavicular line about the level of the third rib. Divide the pectoralis major at the two lateral arms of the incision, exposing the underlying costal cartilages, sternum and ribs. Separate the soft structures from the fourth, fifth and sixth costal cartilages and divide these close to the sternum.

Step [illegible] Separate the mediastinal structures from the sternum by blunt dissection. Remove over three-fourths of the width and [illegible] inches of the length of the sternum with [illegible] rongeur. Dissect the pleural sac on the left from the pericardium (Fig. [illegible]).

Step 3. Incise the pericardium over its [illegible] portion (Fig. [illegible]) and

search for [illegible] line of cleavage. Separate the pericardium from the heart by blunt dissection (Fig. [illegible]). Free the left ventricle before the right ventricle. Sharp dissection may be necessary here and there. Draw the

Fig. [illegible] Fig. [illegible]



[illegible] Fig. [illegible]

Fig. [illegible]. The pericardium was incised over the left ventricle [illegible] to determine the plane of [illegible] between scar and myocardium.

Fig. [illegible]. A plane of cleavage was found and separation was carried out by blunt dissection. The [illegible] seemed to [illegible] the [illegible] to the [illegible].

Fig. [illegible]. The pericardium over the right side of the heart was drawn to the left. The right pleural sac was dissected from the pericardium.

Fig. [illegible]. The pericardium was excised [illegible]. [illegible] over the left ventricle. The coronary vessels stand out well. (Courtesy of Dr. Claude [illegible] Beck.)

pericardium over the right side of the heart to the left with Allis forceps. Dissect the right pleural sac from the pericardium (Fig. [illegible]).

Step 4. Remove the pericardium on the right and over the base of the heart. Excise the scar on the left side down to the emergence of the pulmonary vessels.

Excision of the pericardium [illegible] now complete except for an area posterior to the heart and [illegible] small area over the right auricle [illegible] the vena cavae enter the pericardium and [illegible] the exposure of the structures [illegible] (Figs. [illegible]).

Step 5. Place the flap of soft parts in its bed [illegible] the flap [illegible] with the covering of the heart and pleura.

Step 6. Suture the soft parts with two layers of silk and close the skin with silk. Place [illegible] small drain in the wound thus allowing drainage of fluid or blood and preventing cardiac tamponade. Seal the wound with silver foil and cover [illegible] with [illegible] dressing.

BILATERAL EXPOSURE FOR RESECTION OF PERICARDIUM

The Dpital (Sauerbruch?) incision permits every aspect of the heart to be approached. In his operation for the relief of [illegible] Cutler used this incision in six cases. With this experience as [illegible] background, he felt that probably this exposure was too [illegible] to the patient [illegible] unnecessarily disfigurement.

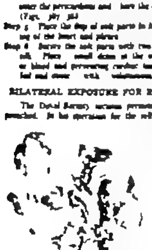


Fig. [illegible]. The portion [illegible] of the pericardium [illegible] [illegible] [illegible] [illegible] the sternum clearly [illegible] [illegible] [illegible] [illegible]

Step [illegible] Make an H-shaped incision [illegible] the crossbar of the H extending over the midline of the sternum and the parallel arms of the H placed at the level of the third costal cartilages above and at the junction of the [illegible] with the sternum below. The transverse incisions extend laterally from the midsternal incision for about [illegible] cm. in each direction. The midline incision [illegible] carried to the sternum. The upper transverse incision transects the pectoralis major muscle for [illegible] short distance at its origin from the sternum.

Step [illegible] Dissect laterally the two flaps of the soft parts thus made to expose the sternum and the costal cartilages. Resect the third, fourth, fifth and sixth costal cartilages on each [illegible] of the sternum.

Step [illegible] Ligate the internal mammary vessels. Dissect the pleural sacs from the pericardium on each side thus providing an excellent exposure well around on each side of the pericardium.

Step [illegible] The left and the right phrenic nerves should be dissected from the pericardium with the mediastinal pleura; the right nerve may or may not be seen along the superior vena cava. The pulmonary vessels can be seen on each side.

Step 5. An almost complete resection of the pericardium can be carried out, leaving only the portion posterior to the heart.

The sternum [illegible] not disturbed. The seventh costal cartilage should not be resected in order that the movements of the diaphragm remain unimpaired. The flaps of soft parts are reapproximated.

WOUNDS OF THE HEART AND PERICARDIUM

Historical Notes. Wounds involving only the pericardium without injury to the heart are rare. The accepted dogma of the ancients that wounds of the heart were invariably fatal was challenged by [illegible] ([illegible]). In [illegible] [illegible] was first to describe [illegible] healed wound of the heart. This concerned [illegible] deer killed in [illegible] whose [illegible] healed wound occurred previously was found by [illegible]. George Fischer in [illegible] in [illegible] study of [illegible] cases of wounds of the heart, mostly in animals, showed that [illegible] per cent recovered. The first to suture wounds in the hearts of rabbits and to show that many recovered and to suggest the feasibility of such attempts in humans was Block, in [illegible]. Morgagni (De Sedibus et Causis Morborum) showed that [illegible] puncture wound of [illegible] coronary artery on the external surface of the heart may cause so great an amount of blood to accumulate in the pericardium as to compress the [illegible] from [illegible] hemorrhage.

At the Eleventh International Medical Congress at Rome in [illegible] Del Vecchio demonstrated healed wounds after suture in the hearts of dogs. The first attempt to suture the wound in the heart of [illegible] human being was made in September [illegible], by Cappelen of Christiania; the second in March, [illegible] by Farina; the third, first successful attempt [illegible] credited to Rehn, September [illegible]. The latter collected, in [illegible], [illegible] cases of suture of cardiac wounds with [illegible] mortality of [illegible] per cent.

Theodor Kocher as far back as [illegible] recalled that at that time there was already too great [illegible] number of methods devised for the exposure and treatment of wounds of the heart. That "the many procedures are at the surgeon's command in this phase of surgery is shown by the fact that Terrier and Raymond, in [illegible], pointed out that in eleven cases of wounds of the heart, ten procedures were used."

True, Kocher says, "that in injuries of the heart the procedure must needs vary depending on the site of injury (right or left to the sternum, above in the region of the auricle or below in the area occupied by the ventricles). Nevertheless, in an emergency situation [illegible] where prompt action is paramount, the surgeon should be conversant with one method which should serve well in all cases."

CARDIORRHAPHY

Kocher Technic

Step [illegible] Prepare the skin of the surface to be operated upon rapidly but thoroughly (soap and warm water, ether, alcohol, [illegible] antiseptics).

Step 2. Make an incision (Figs. [illegible]) about [illegible] cm. in length beginning at the sixth costal cartilage and extending along it to the costochondral junction, through the skin and fascia. Divide the muscle fibers of the pectoralis major muscle at the under surface of the rib and the intercostals on both borders of the [illegible] rib [illegible] and [illegible].

Step 3. After dividing the costal cartilage close to its attachment to

The [illegible] [illegible]

the sternal border parallel to the deep aspect of the bone, and the tendinous insertions and the muscle detached by working the instrument upward and downward

Step 4. Introduce finger through the opening made with the director retracting the tissues and exposing the pericardium

Rehn-Dartmann Method of Pericardiotomy

Step 1. Make an incision between the ribs extending from the sternum externally. In case of injury of the chest, extend the wound inflicted by the missile or knife. The incision is usually made in the fifth intercostal space

Fig. 380. Rehn's method of pericardiotomy

Step 2. With rib spreaders, separate the ribs forcibly

Step 3. Open the pleura (Fig. 380)

Step 4. Grasp the lung with appropriate forceps and displace it outward. If there is not sufficient room for the operative procedures, one should resort to resection of one or more ribs, or if need be, partial resection of the sternum. Where one finds that the approach is beset with greater difficulties, longitudinal median incision through the sternum should be made and the approach to the pericardium sought. In such instances, the incision should begin at the upper border of the third rib and end at the upper border of the sixth. The costal cartilages of the respective ribs are divided close to the sternum and the flap, consisting of bone and soft structures, is displaced upward or downward according to indications. Avoid injury to the internal mammary artery

Step 5. Where there is no emergency existing one may proceed cautiously and carefully avoiding injury to the pleura by working close to the border of the sternum and carefully separating the ribs at the sternal junction. Separate the pleura from the pericardium with great care. Open the pericardium by means of long or transverse incision.

Brauer Operation

Step 1. Make an incision down to the bone to the left, from the mid line of the sternum at the level of, and following the line of the sixth costal cartilage. If necessary the incision may extend to the left mammary line

Step 2. Separate the perichondrium and all the soft parts from the sixth costal cartilage. Excise the cartilage

Step 3. Ligate the mammary vessels in the triangular muscle of the sternum and divide its tendinous insertion into the sternum

Step 4. The exposed pericardium can now be drained and the operation ended if drainage alone is needed

Step 5. If more room is needed, make an incision from the horizontal one upward in the midsternal line to the point desired, usually the level of the second rib

Step 6. Separate the periosteum and soft structures from the sternum to the left of the median line. Divide the fifth, fourth and third left costal cartilages at their insertion into the sternum

Step 7. Push the exposed margin of the pleura upward through the horizontal incision and gradually separate it from the fifth and even the fourth and third costal cartilages

Step 8. After separating the flap from the pleura, fracture or divide the costal cartilages in the flap at their costal insertion

Step 9. Split the pericardium along the sternal margin and laterally along the fifth interspace. This gives access to the heart from the auricles to the apex of the ventricles

Step 10. If more room is desired, sufficient portion of the sternum may be excised with bone forceps or by means of rongeur

Step 11. Wipe away any blood clots in the open pericardium. Suture the existing cardiac wounds with catgut or silk, care being taken not to injure any coronary artery

Step 12. Close the pericardial wound with or without drainage.

Step 13. Suture or drain any pleural wounds which may be present. Don't waste time by trying to remove blood thoroughly from the pleural cavity

CARDIOLYSIS

Decortication of the heart was first recommended by Delorme in 1898. Rehn performed the operation in case of adhesive pericarditis. In 1902, Brauer suggested an operation to which the name cardiolysis is applied, its object being to counteract the damage resulting from adhesive mediastinopericarditis. In substance the principles underlying the procedure are

Delorme's Operation

Step 1. Expose the heart by temporary resection of the thoracic wall

Step 2. Open the pericardium.

Step 3. Manually break down the adhesions existing between the pericardium and heart

Brauer's Operation

This operation is not designed to free the adhesions from the heart but to render them innocuous. This is accomplished by excision of ribs and cartilages, even a portion of the sternum to an extent called for by the existing condition (three ribs or more if necessary). After this the cutaneous flap is replaced. A suitable protection should be worn later over the site of the operation (Fig. 381)

The reader is referred to Schumacker's thorough work on the subject. In brief, his procedure is as follows.

Step 1. Make a flap extending over the third to the sixth ribs inclusive (on the left side)

Step 2. Lift up the flap. Cut the costal cartilages (left) close to the sternum. Resect considerable portions of ribs subperiosteally depending upon the requirements of the case

Step 3. Push back the soft tissues. Smooth the sternal margin with rongeurs.

Step 4. Carefully dissect out the scar tissue surrounding the heart. Avoid opening the pleura

Comments. Usually only the left heart needs decortication. If the left phrenic nerve is found imbedded in scar tissue it may be resected. Free the heart from all restraining bands (diaphragm, etc.). Work carefully on the right side because the wall of the heart is weaker here. Never attempt decortication of the auricles (Schumacker). Nelson recalls

Fig. 381. Scheme of cardiolysis

that an extrapleural resection of ribs (extrapericardial thoracolysis) is an excellent method to afford freedom of movement to the heart. It is a simple and successful procedure provided, however, the cases are well selected

CONTUSIONS OF THE HEART

Claude S. Beck described the "steering-wheel" type of accident producing contusion of the heart which is driven against the spinal column (Fig. 382). The usual symptoms complained of are dyspnoea and weakness. Circulatory collapse may develop. In gross injury of the heart, rupture of the auricles and ventricles may take place

PERICARDIECTOMY

In the Treatment of the Pick Syndrome

Experiments by Claude S. Beck revealed that the essential factor in the production of Pick's disease is fibrosis and contracture of the parietal pericardium or epicardium or both, forming a casing of scar which compresses the heart and

primarily obstructs its filling, interfering with cardiac motion. Generalized adhesions between the epicardium and the parietal pericardium are not sufficient in themselves to produce polyserositis

Coincidental with the development and contracture of scar tissue about the heart, the clinical manifestations of the Pick syndrome in the order of their appearance are (a) rise in the venous pressure (b) ascites and the development of fibrous capsule on the liver (c) hydrothorax and (d) pulmonary and subcutaneous edema. Together with the observations reported, there occurred general weakness and listlessness, a small and rapid pulse, cyanosis and decrease in the minute volume output of the heart. It was shown roentgenographically that the heart and pericardium actually decreased in size and assumed a globular shape as the syndrome developed; after the pericardium was resected, the heart regained its previous size and shape. Not infrequently the compressive effect of the tight scar on the heart can be demonstrated fluoroscopically by the limitation of the systolic and diastolic movements of the heart.

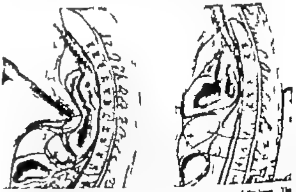


Fig. 382. The "steering wheel" type of accident producing contusion of the heart. The heart is driven against the spine ... dyspnea and weakness are the usual symptoms. In the more severe types circulatory collapse may develop. Auricles and ventricles may be ruptured. (Courtesy of Dr. Claude S. Beck)

The shift of the electrical axis of the heart with a change of position was of slight diagnostic significance in the experiments. It is of greater diagnostic significance in the determination of extrapericardial adhesions.

In tapping the ventricles for specimens of blood for cardiac output determinations, the tapping needle encountered a definite resistance if the parietal pericardium was thickened and scarred. This may be useful as a diagnostic aid in obscure cases

On the basis of experiments it was found that the venous pressure was the most reliable index to the development of this condition. A rise in the venous

[illegible] was always noted before suction or fluid in the chest could be demonstrated.

The closure of [illegible] can almost always be resected. Usually [illegible] plane of cleavage can be found and separation can be carried out by blunt dissection.

Claude S. Beck's Operation

Place the patient in [illegible] position on the operating table. [illegible] other vapor anesthesia.

Step [illegible]. Make an incision beginning at the costal margin in the midclavicular line on the left, curving medially and superiorly to the [illegible]. Follow

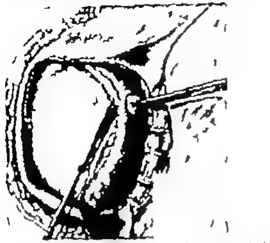


FIG. [illegible]. The fourth, fifth and sixth costal cartilages on the left side were resected and the sternum was partially resected. The pleural sac on the left was separated from the pericardium. (Courtesy of Dr. Claude S. Beck.)

the [illegible] for [illegible] inches and curve laterally to the midclavicular line along the level of the third rib. Divide the pectoralis major at the two lateral areas of the incision, exposing the underlying costal cartilages, sternum and ribs. Separate the soft structures from the fourth, fifth and sixth costal cartilages and divide these close to the sternum.

Step 2. Separate the mediastinal structures from the sternum by blunt dissection. Remove over three-fourths of the width and 3 inches of the length of the sternum with a rongeur. Dissect the pleural sac on the left from the pericardium (Fig. [illegible]).

Step 3. Incise the pericardium over its [illegible] portion (Fig. [illegible]) and

search for [illegible] line of cleavage. Separate the pericardium from the heart by blunt dissection (Fig. [illegible]). Free the left ventricle before the right ventricle. Sharp dissection may be necessary here and there. Draw the

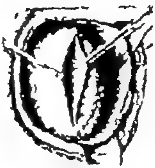
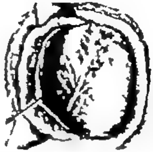


FIG. [illegible]

FIG. [illegible]



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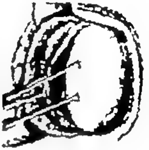


FIG. [illegible]

FIG. [illegible]. The pericardium was incised over the left ventricle. It was [illegible] [illegible] the plane of separation between scar and myocardium.

FIG. [illegible]. A plane of cleavage was found and separation was carried out by blunt dissection. The heart seemed to beter through the opening in the scar to the [illegible].

FIG. [illegible]. The pericardium over the right side of the heart was drawn to the left. The right pleural sac was separated from the pericardium.

FIG. [illegible]. The pericardium was excised in one piece. Pieces of [illegible] scar [illegible] over the left ventricle. The coronary vessels stood out well. (Courtesy of Dr. Claude S. Beck.)

pericardium over the right side of the heart to the left with Allis forceps. Dissect the right pleural sheet from the pericardium (Fig. [illegible]).

Step 4. Between the pericardium on the right and over the base of the heart. Excise the scar on the left side down to the emergence of the pulmonary vessels.

Excision of the pericardium [illegible] now complete except for an area posterior to the heart and [illegible] small area over the right auricle where the venae cavae enter the pericardium and where the exposure of the structures [illegible] inadequate (Figs. [illegible]).

Step 5. Place the flap of soft parts in its bed. The flap [illegible] lined with the covering of the heart and pleura.

Step 6. Suture the soft parts with two layers of silk and close the skin with silk. Place [illegible] small drain in the wound thus allowing drainage of fluid or blood and preventing cardiac tamponade. Seal the wound with silver foil and cover [illegible] with [illegible] [illegible] dressing.

BILATERAL EXPOSURE FOR RESECTION OF PERICARDIUM

The Dual Bilateral [illegible] permits every aspect of the heart to be approached. In his operation for the relief of [illegible], Calder used this incision in [illegible] cases with the [illegible] [illegible] as [illegible] background. He felt that probably the exposure was too shocking to the patient who was not easily decompensated.

FIG. [illegible]. The portion [illegible] the pericardium [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] (Courtesy Dr. Claude [illegible] Beck.)

Step [illegible]. Make an H-shaped incision, with the crossbar of the H extending over the midline of the sternum and the parallel arms of the H placed at the level of the third costal cartilages above and at the junction of the [illegible] with the sternum below. The transverse incisions extend laterally from the midsternal incision for about 5 cm. in each direction. The midline incision [illegible] carried to the sternum. The upper transverse incision transects the pectoralis major muscle for [illegible] short distance at its origin from the sternum.

Step [illegible]. Dissect laterally the two flaps of the soft parts thus made to expose the sternum and the costal cartilages. Resect the third, fourth, fifth and sixth costal cartilages on each side of the sternum.

Step 3. Ligate the internal mammary vessels. Dissect the pleural sacs from the pericardium on each side thus providing an excellent exposure well around on each side of the pericardium.

Step [illegible]. The left and the right phrenic nerves should be dissected from the pericardium [illegible] the mediastinal pleura, the right only as they may be torn along the superior vena cava. The pulmonary vessels can be seen on each side.

Step 5. An almost complete excision of the pericardium can be carried out, leaving only the portion posterior to the heart.

The sternum is not disturbed. The seventh costal cartilage should not be resected in order that the attachment of the diaphragm remain unimpaired. The flaps of soft parts are reapproximated.

WOUNDS OF THE HEART AND PERICARDIUM

Historical Notes. Wounds involving only the pericardium without injury to the heart are rare. The accepted dogma of the ancients that wounds of the heart were invariably fatal was challenged by Hollerius (1498-1562). In 1642 [illegible] was the first to describe [illegible] healed wound of the heart. This concerned [illegible] deer killed in [illegible] where [illegible] healed wound occurred previously was found by [illegible]. George Fischer [illegible] [illegible] [illegible] painstaking study of [illegible] cases of wounds of the heart, mostly in animals, showed that [illegible] per cent recovered. The first to suture wounds in the hearts of rabbits and to show that many recovered and to suggest the feasibility of such attempts in humans was Block in [illegible]. [illegible] Dr. [illegible] showed that [illegible] puncture wound of [illegible] coronary artery on the external surface of the heart may cause so great an amount of blood to accumulate in the pericardium as to compress the bleeding point thus arresting hemorrhage.

At the Eleventh International Medical Congress at Rome in [illegible], Del Vecchio demonstrated healed wounds after suture in the hearts of dogs. The first attempt to suture the wound in the heart of [illegible] human being was made in September [illegible], by [illegible] of Christiania; the second in March [illegible] by [illegible]; the third, first successful attempt [illegible] credited to Rehn (September [illegible]). The latter collected, in [illegible] cases of suture of cardiac wounds with [illegible] mortality of [illegible] per cent.

Theodor Kocher as far back as [illegible] recorded that at that time there was already too great [illegible] number of methods devised for the exposure and treatment of wounds of the heart. That "[illegible] many procedures are at the surgeon's command in this phase of surgery is shown by the fact that Tuffier and Raymond [illegible] pointed out that in eleven cases of wounds of the heart ten procedures were used.

True [illegible] Kocher says, "that in injuries of the heart the procedure must needs vary depending on the site of injury (right or left to the sternum, above at the region of the auricle or below at the area occupied by the ventricles). Nevertheless, in an emergency situation where prompt action is paramount, the surgeon should be conversant with one method which should serve well in all cases."

CARDIORRHAPHY

Kocher Technic

Step [illegible]. Prepare the skin of the [illegible] to be operated upon rapidly but thoroughly (soap and warm water, ether, alcohol, [illegible] [illegible]).

Step [illegible]. Make an incision (Figs. [illegible]) about 10 cm. in length beginning at the sixth costal cartilage and extending along [illegible] to the costochondral junction through the skin and fascia. Divide the muscle fibers of the pectoralis major muscle at the under surface of the rib and the [illegible] [illegible] borders of the rib with knife and rongeur.

Step 3. After dividing the costal cartilage close to its attachment [illegible]

Cut. Continued on p. [illegible]

pull it up with a hook and sever it at its junction with the cartilage of the seventh costal cartilage.

The internal mammary vessels now appear about a finger's breadth from the border of the sternum. Ligate these doubly and divide them. The triangularis sterni muscle is now found under these vessels. Divide this close to the sternum.

Step 4. Displace the muscle and the pleura adhering to it laterally. The point of reflection of the pleura is frequently recognized by a pad of fat and may usually be easily separated from the pericardium. Expose the latter until its attachment to the diaphragm is visible. If at this point it appears that

F[illegible] [illegible] F[illegible] 1390

Fig. 1389. Kocher's method of exposure of the heart. Formation of osteoplastic flap.
Fig. 1390. Exposure of the heart by Kocher's method. The flap consisting from the sternum ... in the previous illustration. The sixth costal cartilage has been resected. Between the divided ends of the cut bow the pericardium is visible. The triangularis sterni muscle, the internal mammary artery and vein are exposed.

the pericardium may be promptly opened it may be done now. If not, proceed as follows.

Step 5. According to the position of the wound in the heart, enlarge the incision in the median line of the sternum upwards to the costal cartilage of the fourth, third or even second rib. Add to this vertical incision a horizontal cut about 8 cm. long dividing the fibers of the pectoralis major along their attachment to the rib, usually the third, from the upper border of which the fibers of the intercostal muscles are bluntly separated.

Step 6. Push off the pleura bluntly from the under surface of the fifth costal cartilage together with the triangularis muscle. Divide this cartilage close to its attachment to the sternum. Repeat the same procedure with the cartilage of the fourth and third ribs.

Step 7. Elevate the severed cartilages, push the triangularis muscle and pleura laterally. Break the flap consisting of the cartilages at their junction with the respective ribs, or if necessary, by dividing the ribs further outward. Displace these outwards thus exposing the pericardium from the muscles

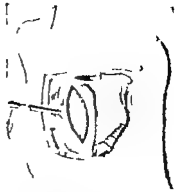


Fig. 1391. Exposure of the heart. Kocher's method.

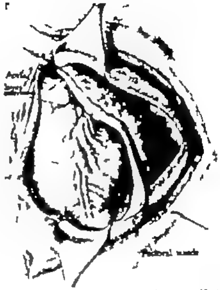


Fig. 1392. Exposure of heart by intercostochondral thoracotomy. (Courtesy of Dr. Claude S. Beck.)

Fig. 1393. First step in method of controlling flow of blood through heart by compression of heart. Third finger is placed through great transverse sinus ... the fingers are placed posteriorly in pericardial cavity. By compression with the fingers the venae cavae and the pulmonary veins can be occluded. (Courtesy of Dr. Claude S. Beck.)

Fig. 1394. Second step in method of controlling flow of blood through heart by compression of heart; the heart is clasped between the thumb and the index finger. (Courtesy of Dr. Claude S. Beck.)

(Fig. 1392) down to the apex. If the pleura is inadvertently opened, close it at once (Terrier and Reymond).

Step 8. Enter the opened pericardium and lift the heart out with two fingers. The apex is held by Museux forceps as recommended by Terrier and Rey-

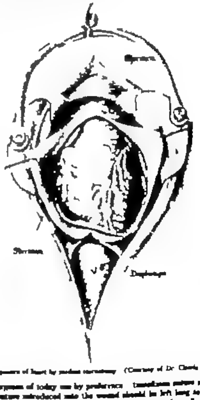


Fig. 1395. Exposure of heart by median sternotomy. (Courtesy of Dr. Claude S. Beck.)

mond. Surgeons of today use by preference interrupted sutures in the first ... The first suture introduced into the wound should be left long so that when traction is put upon it, continuous suture may satisfactorily be placed (Bohm). To put a finger into the wound of the heart is dangerous practice (E. C. Cutler). Avoid inclusion of a coronary vessel in the suture. The

silk should be the suture material. The whole hand, if need be, may be introduced into the pericardium when the occasion demands better exposure of the wound in the heart. Pass the sutures quickly, preferably during diastole. Pass the curved needle carrying the suture quickly and dexterously through the myocardium but not through the endocardium.

To control bleeding, Sauerbruch recommended the following grip. The left hand is placed in the region of the base of the heart. The third finger passes through the greater transverse sinus and anterior to the vena cava and pulmonary veins and posterior to the aorta and pulmonary artery. The fourth and fifth fingers rest on the auricles, posterior to these structures and the vena cava. As the third finger is approximated to the other two the flow of blood into the heart is stopped, and when this has been accomplished, pressure with the index finger and thumb may be exerted to steady the organ and deliver it into the field.

Fig. 1296. Dreyer's rapid method of exposure of the pericardial region. U-shaped incision with external hinge.

No definite rules can be laid down as to suturing; some prefer continuous sutures, others interrupted, the latter I believe on the whole, are preferable. (Claude S. Beck uses the steps depicted in Figs. [illegible] in suturing of the heart.)

Step 9. The modern surgeon need not be reminded of the importance of strict asepsis in performing these operations. Cleanse the pericardial sac. Close completely, unless infection exists or faulty asepsis is suspected. On general principles, I prefer a small drain in the pericardium. Suture the pleura completely if opened.

Step 10. Close the wound.

Comment. Many surgeons prefer Duval Barasty's Extrapleural Pericardiotomy (see p. [illegible]). Others resort to the Kocher Thoracic-Abdominal approach to the heart. Intratracheal anesthesia becomes a necessity in many cases.

Dreyer's Rapid Method of Approach to the Heart for Wounds, Etc.

Step 1. Make a U-shaped incision in such a manner that a similar flap with an external hinge results (Fig. 1296). The cutaneous opening of the wound (missile, stab, etc.) should be circumscribed by the incision.

Step 2. Divide the pectoral muscles and expose the costal cartilages and ribs.

Step 3. Divide the third, fourth and fifth costal cartilages with Dreyer's costotome rongeur (Figs. [illegible]).

Step 4. Incise the third and fourth intercostal spaces. Divide the outer branches of the U-incision (third rib above and fifth rib below); avoid the internal mammary vessels. Reflect the shutter thus formed outward. Fracture the intervening ribs during its displacement.

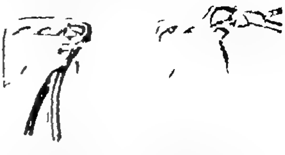


Fig. 1297. Fig. 1298.

Fig. 1297. Dreyer's rapid method of exposure of the pericardial region. U-shaped incision with external hinge. [illegible]

Fig. 1298. The Dreyer instrument (costotome rongeur) has cut through the third rib [illegible] (After Dreyer.)

Step 5. Raise the margin of the incision; expose the internal mammary vessels. The pericardium is incised at the point of perforation. Clean out clots. Suture the wound in the heart. Do not strangulate the tissues while suturing.

Step 6. Suture the pericardium.

Step 7. Close the wound layers; small wick drain.

CLAUDE S. BECK'S METHOD OF CONTROL SUTURES

When the pericardium is opened, in order to steady the heart is placed at the apex, the wound in the heart being momentarily disregarded. The impulse to control the bleeding instantly by placing a finger on the wound should not be heeded until the apex suture is placed. Unless the heart be steadied, the finger cannot be maintained in position. The apex suture is held under traction between the thumb and the third finger of the left hand, and the index finger is placed on the wound (Fig. 1299). The bleeding is thus controlled. The movements of the heart are transmitted to the left hand, both active [illegible] so that the index finger can be maintained effectively on the wound. This can be done regardless of its position on the ventricles. Two control sutures taking a deep bite of muscle are placed, one on each side of the finger at the level of the wound. They are crossed and then held under gentle traction by the assistant as the index finger is removed. The apex suture is dropped. An ad-

[illegible] exposure of the controlled wound is provided and ample time may be taken in placing the permanent sutures (Fig. 1300). Coronary vessels, if they lie adjacent to the wound, can be avoided in the sutures and a neat approximation can be obtained. The apex and the control sutures are removed.

The heart of the operation [illegible] when the index finger is placed on the wound while the heart is steadied by a firm hold on the apex suture. If the idea be fixed in the operator's mind first to place a suture in the apex, disregarding the wound momentarily, the suture can be placed in a few seconds and the subsequent procedure becomes remarkably simple. The flow of blood through the heart [illegible]

Fig. 1299. Beck's method of control [illegible] the heart. The pericardium [illegible] wound and blood [illegible] the apex of the heart. This suture [illegible] finger when the index finger is placed upon [illegible] The index finger [illegible] maintained upon the wound [illegible] Courtesy Dr. Claude Beck.

[illegible] and sufficient time may be taken in completing the procedure with deliberation. The surgeon should have moved the position of the wound under the finger so that the control sutures can be placed at the level of the wound. These should be placed [illegible] the margin of the wound as the overlying finger allows. Traction on them [illegible] advantageously applied when they are held by the assistant an inch or two from the wound. The traction should not be so strong as to tear through the muscle. If [illegible] bound as removal of the index finger that the bleeding is not entirely controlled, the finger may be replaced on the wound and another control suture placed on each side of the point where the bleeding occurred. The four control sutures, two from each side, are crossed and held by the assistant. In this way a wound almost any size can be controlled, and a good exposure for placing the permanent sutures can be obtained.

The method has the advantage in that the flow of blood through the coronary

and the cerebral vessels is not occluded. It is well tolerated so that ample time may be taken to complete the procedure. An opportunity is afforded in placing the permanent sutures to avoid inclusion of adjacent coronary vessels. A neat approximation can be obtained.

New Blood Supply to Heart

Claude S. Beck has done experimental work with the object in view of creating a new blood supply to the heart by surgical means. He has extended his work to human beings with reported apparent success. More material, of course, is needed to arrive at definite conclusions on this very interesting and important phase of surgical endeavor. (Figs. [illegible])

Fig. 1300. The control sutures are crossed and held by the assistant. The finger is then removed and gentle traction is applied to the control sutures. The wound is now exposed. There is no bleeding. Permanent sutures are placed in the wound. (Courtesy of Dr. Claude S. Beck.)

Comment. Anthony L. Lockwood[*] in commenting on the surgery of the pericardium and heart reached the following conclusions:

"1. The heart is tolerant of severe trauma and manipulation.

"2. The danger of 'heart-tamponade' [compression of the heart] must be constantly kept in mind. One must appreciate that if the patient has lost much blood, with the lowered tension, the shock and the ability of the heart to withstand pressure, the wound in the heart may temporarily cease to bleed. As the patient's condition improves and the blood pressure rises, primary hemorrhage may occur and the patient be found to [illegible] again, if not constantly observed.

*Surg. Gynec. and Obst., [illegible] J. Am. [illegible]

SUBJECT INDEX

VOLUME THREE

Part V

SURGERY OF THE ABDOMEN

ORIENTATION

Tremendous strides have been made in surgery of the abdominal organs. There is a growing tendency to abandon the interrupted suture in abdominal closure (Chapter 32). Through-and-through sutures are at times measures of direct value (Mont Reid). The method I described eliminates the depositing of too much suture material and has yielded in our work a very low incidence of infections and almost complete elimination of eventrations. Modern methods of operating upon the stomach and intestines (Chapters 33 and 34) have been described at length. In intestinal surgery the avenues of surgical approach have been widened by the contributions of Miles, Mummery, Rankin, Jones, Devine and others. Unfortunately late diagnosis of carcinoma of the stomach and of the large bowel claims too many victims. Gastroscopy, early proctoscopy and biopsies are often recorded when metastases have occurred. Treatment, therefore, is of little benefit to the patient. Catastrophes, the result of acute intestinal obstructions, may be averted by proper evaluation of diagnostic criteria and proper treatment. In this connection the names of Levine and Wangensteen stand out in bold relief. Proper interpretation of ... phenomena of the intestines will do much to clarify the diagnosis ... has developed.

Gordon Watson states that over half the cases admitted to St. Mark's Hospital for fistula in ano have been operated upon elsewhere and more than once. Lockhart-Mummery's postulates still hold true for failures in fistula operations (inadequate operation, insufficient drainage, tight plugging of the wound, bridging of the wound or some constitutional disease of the patient). Already Shakespeare has pointed out the difficulties of fistula operations.

Countess. What hope is there of his majesty's amendment?
Lafeu. He hath abandoned his physicians, madam; under whose practices he hath persecuted time with hope; and finds no other advantage in the process but only the losing of hope by time.
Bertram. What is it, my good lord, the king languishes of?
Lafeu. A fistula, my lord. (Act I, Scene I of All's Well that Ends Well).

In Chapter 35 on the Surgery of the Liver and Biliary Passages, I have culled from the outstanding work of contemporary surgeons (A. J. Walton, W. J. Mayo and others) constantly checking the work of pioneers. My operation on electrosurgical obliteration of the gallbladder is described in entirety. Every author is inclined to be enthusiastic about his own procedure. Time usually establishes the justification or fallacy of overenthusiasm. Physiology has uncovered many new facts which changed surgical thought here considerably (Graham, Cole, Ivy and others). This also holds true in surgery of the pancreas (Chapter 36). The studies of ... and others have done much to clarify some of these problems. The spleen (Chapter 37) is still the problem that it was. In Chapter 38 on Hernia I have surveyed most operative procedures from the time of Bassini to our day and have included those operations which I felt would serve the purposes of elucidation and clarity best. The fundamental principles laid down by the Masters, few but valid, still rest on solid basis. They have been elaborated, to be sure, but in principle not supplanted.

CHAPTER 32

METHODS OF OPENING AND CLOSING THE ABDOMEN

OPENING THE ABDOMEN

The essentials of a proper incision demand that it
(1) Afford proper access to the pathologic process sought
(2) Be of such a nature that it may be easily enlarged
(3) Avoid unnecessary injury to the nerves, bloodvessels and muscles of the abdominal wall which may eventuate in hernia (Fig. 1405)

Fig. 1405. The nerves and blood vessels of the anterior abdominal wall. ...

(a) Period of easy and secure closure

To open the abdomen as to incise structures in any other part of the body knives (usually referred to as scalpels) are used. These must be of keen edge. Removable blades are often used.

NERVE SUPPLY

The nerves of the abdominal muscles generally run in the same direction as do the muscles—hence incisions along the muscle fibers of a given muscle are

apt to cause the least damage. The nerves of the rectus abdominis muscle are an exception. A longitudinal incision in the linea alba is the most classical of incisions. It is simple and effective. Unfortunately the structures here are so attenuated that hernia frequently results. T[illegible] would thus the incisions are usually placed lateral to one or the other side of the linea alba; the sheath of the rectus muscle is

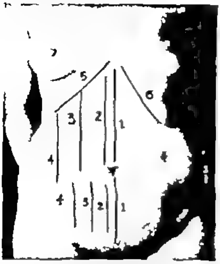


Fig. 1206. Commonly used longitudinal incisions in approaching the abdominal viscera. Median incision. Paramedian incision (Hagen-Thorn [illegible]). 3 Transrectus incision (Bevan). Upper abdominal pararectus incision (Lennander, [illegible]) and lower abdominal pararectus incision (Lennander-Battle-Kammerer-Jalaguier). 5. Kocher incision for exposure of the liver and biliary passages. 6. [illegible] incision.

opened and the rectus displaced laterally and the posterior fascial sheath and peritoneum opened.

Longitudinal incisions above the umbilicus are usually difficult to close because of tension.

The nerve supply of the abdominal wall springs from the (Fig. 1209)

1. Lower six dorsal nerves.
2. The iliohypogastric and
3. The ilio-inguinal nerve.

These enter the abdominal wall by piercing the transversalis and internal oblique muscles and with the exception of the ilio-inguinal nerve pass forward to the outer border of the sheath of the rectus abdominis muscle which they enter. The intercostal nerves divide into two branches after they enter the sheath of the rectus. The larger branch proceeds onward behind the muscle, piercing it from behind and giving off branches which supply entirely the inner

half of the muscle and ends as the anterior cutaneous nerve; the smaller branch enters the outer portion of the rectus muscle which it supplies. It [illegible] thus be seen that extensive vertical incisions through the rectus muscle at its outer margin

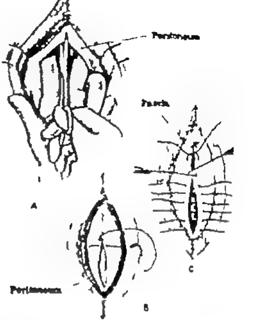


Fig. 1207. A. Method of closing peritoneum with sutures. B. Method of closing peritoneum with continuous catgut suture. C. Method of closing fascia. The [illegible] closing the fascia with interrupted catgut sutures. A [illegible]

(except the median, paramedian or transverse incisions) will injure the nerve supply more or less and predispose to postoperative hernia.

The least harm results by making the incision through the inner edge of the rectus muscle. The so-called Battle-Kammerer or Lennander incision is made parallel to the lower three inches of the semilunar line and one-half inch within it. Divide the outer edge of the sheath of the rectus abdominis muscle longitudinally and displace the muscle inward.

If it be necessary to enlarge the incision beyond the umbilicus, cut around it, generally to its left side, or if necessary excise it.

Generally speaking, median longitudinal abdominal incisions are placed as

outlined in Fig. 1206. The important point to remember is that the incision should be ample. A quarter of a century ago many of us were proud of the smallest incision through which we could perform an abdominal operation. These were those that I like to call "button hole artists." Many complications and disappointments followed these ambitions. Many pathologic conditions within the abdomen were overlooked because of them. Such attempts are an injustice to the patient, in the modern light, and a distinct disregard of the requirements of proper exposure so essential to good surgery.

After the skin and subcutaneous tissues have been divided, clamp and ligate bleeding points. Drape the skin. The scalpel is discarded after the skin is divided. Incise the fascia and muscle. Open the peritoneum as shown in Fig. 1207,A.

Detailed descriptions of incisions used in given operative procedures will be discussed under their respective headings.

INCISIONS

The Paramedian, Pararectus and Transrectus Incisions

(Lennander, Battle-Kammerer, Jalaguier)

Step 1. Palpate the medial border of the right rectus abdominis muscle.

Step 2. Incise the skin longitudinally a short distance to the right of the median line. Let the incision begin about [illegible] cm from the medial border of the rectus. Expose the aponeurosis of the rectus muscle.

Fig. 1208. Paramedian incision (Lennander). The border of the rectus abdominis muscle is displaced outwardly, the posterior sheath of the rectus and the peritoneum are opened.

Step 3. Open the anterior sheath of the rectus sheath along the extent but somewhat shorter than the cutaneous incision.

Step 4. Free the internal border of the rectus muscle, retract it outward. Be careful, while retracting the muscle outward not to injure the deep epigastric vessels which course between the muscle and its posterior sheath. Occasionally the relation of the vessels is such that they may have to be divided between ligatures. Open the posterior sheath of the rectus muscle and peritoneum (Fig. 1208). The beginner should pick these structures up with thumb forceps and carefully divide them. The experienced surgeon may omit the forceps and open the peritoneal cavity without instrumental aid. The paramedian incision the author uses in female patients and for exploratory cases. In males and in interval appendices the pararectus incision used is as follows:

( ) Make an incision similar to the one described (about three-quarters of an inch internal to the outer edge of the rectus abdominis muscle).
(b) Retract the muscle inward.
(c) Open the peritoneal cavity.

Caution. The aponeurosis [illegible] may be over-developed, tending to [illegible] the beginner. In such cases, proceed cautiously lest adherent viscera be injured.

Transrectus Incision

(a) Proceed as in the preceding, making the incision over the midportion of the respective rectus muscle.
(b) Open the anterior sheath of the muscle.
(c) Split the muscle bluntly in the long axis of its muscle fibers with the handle of the scalpel.
(d) Open the posterior sheath of the muscle and the peritoneum.

Transverse Incisions

These will be described under the captions where indicated (Figs. 1209-1210). The general direction of these incisions is transverse. Special types of transverse

Fig. 1209. Commonly used transverse and oblique incisions. [illegible] right transverse incision. [illegible] left transverse incision [illegible] incision for the exposure of the appendix. Pfannenstiel incision. [illegible]

Fig. 1210. Pfannenstiel incision.

incisions are of the Bartlett type. W. Bartlett, Sr. and Jr.[1] observe that all modifications of an upper abdominal incision, transverse as most layers, possess definite advantages over all vertical incisions, in which the rectus is retracted laterally out of its sheath. ( ) Injury to nerve supply is avoided. ( ) The posterior aponeurosis of the flat muscles, the main supporting structure in the upper abdomen, [illegible] split parallel with its fibers. (3) Intra-abdominal exposure is greatly improved. (4) Closure is always facilitated. (5) Postoperative wound shows noticeably less tendency to retract, little pain on respiration, and shorter confinement with consequent economic gain. (6) There [illegible] evidence that the risk of respiratory complications is less. (7) Decreased risk of hernias and adhesions and better cosmetic result.

BARTLETT PROCEDURE

Step 1. The primary incision may be made vertically, being carried down through the skin and aponeurosis, followed by retraction of the rectus and transverse division of the posterior aponeurosis and peritoneum. Or, classic transverse incision of all layers may be made in one plane. In other

[1] Surg., Gynec. and Obst., [illegible]

cases the staggered incision may be used. The linea alba was the site of incision in some instances while a portion or all of the rectus of the opposite side was divided in a few cases.

In gallbladder operations the skin incision is indicated by a scratch. The head of the table is elevated. The liver edge and costal margin are marked. The next line of incision is directed from the midline to the left to the liver margin extending to the rib margin.

Step 2. After the skin and fat have been divided, carefully brush away the fat from the anterior fascial aponeurosis for a width of [illegible] cm. From the upper border of this incision open the anterior aponeurosis from the midline to the lateral border of the rectus and continue the incision laterally upward between the fibers of the external oblique.

Step 3. Insert a narrow retractor into the lateral angle of the incision and pull the lower border of the external oblique and its fascia, which are thus split laterally from the border of the rectus. The aponeurosis anterior to the rectus has, at that time, usually retracted so that about [illegible] cm. of muscle is exposed. If not, dissect off the lower flap of the anterior aponeurosis.

Step 4. Insert a hemostat under the rectus and divide it along the lower edge of the exposed region, beginning at the lateral border.

Step 5. While the edges of the wound are held apart with retractors, incise the transversalis fascia and peritoneum at the upper level of the aponeurosis. If it is desired to explore the ducts, the incision is continued through the linea alba. If not, the incision terminates at the linea alba.

Drains are brought out obliquely through the opening in the flat muscles at the lateral margin of the wound. The muscles tend to unite quickly, making the oblique drain preferable to one piercing it directly. The collapse of an oblique tract by forcing the inner against the outer wall is caused by intra-abdominal pressure exerted radially in all directions. Until he has become familiar with this procedure, the surgeon is likely to find himself spending more time on the abdominal wall than anything else, but in time it is done with as great facility and rapidity as through the Kammerer incision. *Closure follows more surely and quickly. Exposure is much better* and the small intestine is not likely to push out.

G. A. Sloan[1] described a combination of straight transverse and transverse intermuscular incisions for which he claimed the following advantages:

(1) Almost complete absence of tension on the sutures of the posterior fascia layers reduces the probability of postoperative adhesions to the abdominal scar. The danger of wound separation and hernia is almost entirely eliminated.

(2) Ample exposure is afforded for all operations in the upper abdomen.

(3) Four fifths of the postoperative discomforts following longitudinal incisions are prevented.

(4) Closure is accomplished with great ease. One anesthesia is sufficient; deep anesthesia is not required. Convalescence is shortened, and a better scar is secured.

Comment: My preference is, as stated, for vertical incisions. In enlarging an incision downward steer clear of the urinary bladder. The best complement to abdominal incision the [illegible]. I use the pararectus incision for

[1] "A New Abdominal Incision" Surg. Gynec. & Obst., Mar. 1927.

interval appendectomies. In women and in men where the diagnosis is doubtful the transrectus incision has served me best. The Pfannenstiel incision is reserved for cases where, for esthetic reasons, it is definitely indicated.

In extending an incision upward, do not go beyond the ensiform cartilage; you may inadvertently open the pleural cavity with resulting pneumothorax and subcutaneous emphysema. In suturing the posterior sheath do not puncture the epigastric vessels—a large hematoma will result behind the muscle from overlooking this precaution.

Where drains are used, see that these are not compressed by too tight suturing around them.

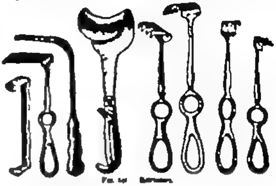


Fig. 141. Retractors.

Wound infections are occasionally a source of dissatisfaction to both patient and surgeon alike.

EXPOSURE BY RETRACTION

To keep the wound open, a variety of retractors are marketed. Different types of retractors are preferred by different surgeons. Generally speaking, the types of retractors depicted in Fig. 141 offer a selection to meet most needs. The simpler the retractor the better.

PAINFUL POSTOPERATIVE ABDOMINAL SCARS

Frederic W. Bancroft[1] points out that many patients complain of postoperative soreness in the region of scars, often very severe. These are sometimes diagnosed as postoperative adhesions. Often, at secondary exploration, insufficient pathologic change is found to account for the symptoms. Bancroft thinks some cases are due to neuromas in the abdominal scar.

The literature in regard to neuromas or neuritis of the abdominal scars is scant. This condition is more prevalent than is generally believed.

[1] Annals of Surgery, August 1930.

The microscopic proof of this lesion is extremely difficult, as the nerves traversing the scar tissue are extremely small and their identification in the excised tissue almost impossible.

The assumption that the symptoms and pathologic changes in Bancroft's four cases were due to neuromas or traumatic neuritis of the lower thoracic nerves is based on the following data: 1. In three cases the injection of procaine hydrochloride into the fascia of the right rectus muscle relieved the pain for various periods of time. 2. The patients in three cases were relieved from symptoms by excision of the scar tissue en bloc without opening the peritoneum. In the fourth case the peritoneum was opened to inspect the abdominal contents, and there was insufficient pathologic change in the peritoneal cavity to account for the patient's symptoms. 3. The peripheral pain in amputation stumps has been definitely shown to be due to neuromas, and the microscope has confirmed this diagnosis.

Bancroft is convinced that injuries to the nerves are more common in abdominal wounds than is generally recognized. There are many cases of denervated masses of muscle where nerves have been cut. While there is no evidence of definite hernia, relaxed and atrophied muscles are seen which must cause some functional interference. It seems that the methods of operative approach to the abdominal cavity must be reconsidered. The tendency has been to attempt to follow muscle planes, and frequently to sacrifice ruthlessly the accompanying nerves. It is known that muscles heal kindly even if cross-cut, provided there is no infection. It would therefore seem that surgeons should readjust their ideas to attempt to place incisions so that they run parallel with nerves. If this theory is adopted, how is one to approach the abdominal cavity? The following suggestions are made:

Wherever possible incisions through the right rectus muscle should be eliminated from the surgeon's armamentarium for the following reasons: 1. Percentage of hernias after a right rectus incision is higher than after most incisions. 2. Frequently weak wounds are encountered, because the portion of the rectus muscle medial to the scar is paralyzed or at least inhibited in action. 3. Injuries to the nerve are more apt to occur when this type of incision is made. In making a right rectus incision one frequently encounters the deep epigastric vessels. There is usually a considerable amount of hemorrhage, and it is impossible to isolate the nerves going to the muscle so that it is easy to place a ligature about both vessels and nerve. Frequently hematomas result from the artery to the wound, and in some cases definite thrombosis has been noted along the course of the vessel extending as far as the femoral vein.

In the upper right rectus incision the transversalis fascia runs directly from the intercostal margin to the navel line as a well developed layer. It is difficult to close this layer by sutures. When the patient vomits or coughs, the spread of the ribs puts extreme tension on the suture line. Tearing of the fascia is frequently the forerunner of a ventral hernia.

If the surgeon prefers an incision to the right of the median line, either for exploration or for a better approach to the appendix, the Kammerer modification seems preferable to the usual right rectus incision. When the rectus muscle has been drawn to the mesial side the nerves can be easily identified and retracted up and down, so as to allow a satisfactory exposure (Fig. 142).

Moreover, if it is necessary to sacrifice a nerve, it can be done under the eye, so that no unnecessary ligature is placed about it. In this type of incision, deep epigastric vessels are not encountered, and therefore there is less hemorrhage.

Often the surgeon wishes to remove an appendix and at exploration finds pathologic changes in the region of the gallbladder. The problem then presents itself whether to enlarge the incision—with the possibility of a weak scar—or to close the lower incision and make a second one with the resultant loss of time. Bancroft suggests that if a Kammerer incision has been made, the wound may be extended by a high oblique incision—one parallel to the McBurney incision—

Fig. 142. The Kammerer incision. The rectus muscle is drawn mesially. The nerves may be seen entering the rectus muscle and can be retracted either upward or downward. [illegible] ... they may be cut without ligature. (Courtesy of Dr. F. W. Bancroft.)

which begins at the rectus sheath and ends at the ninth costal cartilage in the axillary line. By this incision it is necessary usually to cut only one nerve, that at the upper angle of the Kammerer incision. This nerve can easily be seen at the first incision, and can be cut without danger of ligating it with the accompanying vessel. The extension of the incision runs parallel to the course of the intercostal nerves. A satisfactory exposure can be obtained thereby (Fig. 143).

Bancroft concludes:

1. Injuries to the nerves in abdominal incisions followed by neuromas or neuritis are more prevalent than is generally recognized.
2. They are probably often produced by ligating a blood vessel with its accompanying nerve.
3. In the cases reported by Bancroft the right rectus incision was the procedure followed.
4. Diagnosis of neuroma may be made by ferreting out

of the nerve and by causing cessation of the pain by temporarily blocking the nerve by injecting procaine hydrochloride. In right rectus incisions this is accomplished by injecting procaine hydrochloride beneath the fascia of the right rectus muscle.

5. Incisions for abdominal exposure should be planned to avoid trauma to the nerves. Mass ligature of vessels in the vicinity of nerves should be carefully avoided.

Fig. 1413. Extension of right rectus incision (Kehrer) for exposure of gall-bladder ... incision ... parallel to nerves so that only one nerve ... cut during exposure. (Courtesy of Dr. F. W. Bancroft.)

Many persons have a great tendency toward keloid formation (Fig. 1414).

Comment. Incisions requiring special technical maneuvers should be done only by those thoroughly conversant with such steps. For general purposes, and unless otherwise specially indicated, a well-placed vertical incision (keeping in mind anatomical peculiarities of the region operated upon and coupled with painstaking attention to detail) is preferable to complicated and technically difficult procedures. The various incisions will be discussed under the respective operations.

CLOSING THE ABDOMEN

FOREIGN BODIES LEFT IN THE ABDOMINAL CAVITY

It is a well known fact that surgical instruments, sponges, etc., are many times left in the body, particularly in the abdomen, following operations. They are often responsible not only for the failure of the operation but for the existence of conditions necessitating a second operation or in many cases for the invalidism and death of the patient.

In some instances the occurrence may be condoned since emergency operations are often performed without the deliberate procedure which really should

Fig. 1415. Keloids following laparotomy in female patient twenty years of age. (After Lund.)

be associated with each surgical intervention. Under stress, a surgeon who does not accurately count his instruments, sponges, etc. may be excused if it was necessary to close the wound hurriedly. Also it may happen to an otherwise careful surgeon if the patient becomes moribund on the table necessitating the immediate discontinuance of the operation. The surgeon should not be condemned or criticized until all circumstances of such a case are known. Deliberate surgical neglect may be attributed to the surgeon if it is proved that he failed to check his armamentarium before and after the operation even though he had sufficient time, or if he did not inquire into all phases relative to the matter under discussion before closing the incision.

Many cases are recorded where a surgeon discovered too late that a foreign body had been left in the abdomen and rather than admit his mistake (for reasons legal and otherwise) left it in with the hope that it would become encysted or quiescent and not cause the patient any serious harm.

In every properly conducted hospital, a careful count is made, before and

after operations, of all instruments, sponges, etc. used, and it goes without saying that the conscientious surgeon will always satisfy himself that everything is checked up and correct before an operative wound is closed. But there is the human equation and a possibility of an error in counting, even by two persons, must be reckoned with. I have mentioned elsewhere in this work the method I have used successfully for many years, of attaching a metal ring to the end of each laparotomy sponge. In every suspicious case the abdomen should be subjected to x-ray studies before the patient is discharged from the hospital.

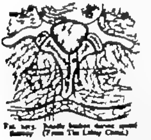


Fig. 1416. Needle broken during spinal anesthesia. (From The Lahey Clinic.)

Some surgeons insist that towel clips should never be used, but the towel, preferably fixed in place by a suture. I often employ Doyen clamps.

No instruments with loose parts, that are likely to become detached, should be used.

As hemostatic forceps seem to be the surgical foreign body most often left behind, surgeons should pay particular attention to them.

Besides using rings, as stated above, attached to lap-sponges, I have been much impressed and occasionally used, successfully Crossen's "saddle bag" arrangement. This consists, in one bag, of a strip of gauze, ten yards long and about three inches wide, which is attached to the bottom of one compartment of

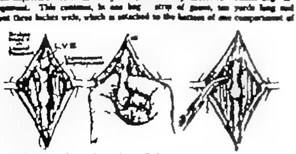


Fig. 1417. Method of removal of broken needle from spine. (From The Lahey Clinic.)

the saddle bag. It is used as needed and the soiled portion placed in the other compartment of the bag.

Many mishaps from an incorrect sponge count, and untold charges to both patient and physician may be avoided by a more general use of Crossen's "ten-yard-strip-sponges" in saddle bags.

The same author has also compiled and tabulated a list of a series of two hundred and forty foreign bodies, left in the abdomen and lost after vaginal operations, by various operators, covering the period between 1899 and 1900.

Dr. H. S. Crossen, American Journal of Obstetrics (Vol. 92, January 1925 ...)

There is also the question of foreign bodies resulting from the breaking of a defective surgical instrument during an operation, with a piece remaining behind. Many such instances are known, especially in oral surgery. It is not unusual, in general surgery for a needle to break in suturing tough tissues, or for a piece of a needle to snap off during the induction of spinal anesthesia. Lahey of Boston, called attention to this latter accident (Figs. 1416-1418). Such

Fig. 1427. Drainage tube lost in the chest during an emergency operation. (Discovered three years later.)

Fig. 1428. Human hiatus ligament.

small foreign bodies are apt to be overlooked, but often form a nucleus for later trouble.

Figure 1427 shows a drainage tube left in the chest of a patient over a period of three years. I once found a portion of an instrument that remained in the abdominal region for over ten years.

PROTECTION OF RAW SURFACES

In intra-abdominal operations raw surfaces favor adhesion formation. The surgeon's aim is to cover denuded areas by covering them with peritoneum, omentum or serosa from a contiguous viscus.

Omental, free or pedicled grafts, may be sutured over the denuded area. Approximation of serous surfaces such as after bowel denudations, are frequently resorted to.

In upper abdominal surgery I often have recourse to the use of the falciform ligament either as a pedicled or free graft (Fig. 1418).

Recently Dr. Clifford U. Collins concluded that "if a patient has attacks of vomiting without fever or an increase of the white blood count following cholecystectomy the condition of adhesions of the pyloric portion of the stomach to the fissure in the liver should be considered." Collins explains the situation between the pyloric portion of the stomach, duodenum and the fissure of the

loop in order to prevent harmful adhesion formation. He claims no originality for the method and where no omentum is available he interposes the right portion of the transverse colon. For some years past I have endeavored to obviate the effects of undesirable adhesion formation under such conditions by mustering the falciform ligament into service. The procedure follows.

The ligament is detached completely from its moorings on the anterior abdominal wall. In separating the ligament the resulting raw surface on the posterior aspect of the anterior abdominal wall should be carefully sutured, otherwise undesirable bleeding might ensue.

Fig. 1419. The use of the completely detached falciform ligament to reinforce suture lines on the stomach. [illegible]

The freed ligament may then be attached to the upper border of the peritoneum in the gallbladder bed. Additional tacking of the ligament to the hepatoduodenal ligament or other contiguous smooth surfaces with a stitch or two, gives an efficient protective layer and prevents the viscera from adhering to the gallbladder bed after classical cholecystectomy.

During the respiratory excursions the stomach glides over the falciform ligament in its new position and does not adhere at an undesirable site.

In classical cholecystectomy I have also implanted the divided end of the cystic duct, into the lower third of the falciform ligament, thus covering the duct with peritoneum instead of permitting it to swing freely in the abdominal cavity.

Similarly the ligament may also be completely detached and sutured over the inverted and closed duodenal stump following gastrectomy. On occasion I have also used the detached falciform ligament as a covering for the suture

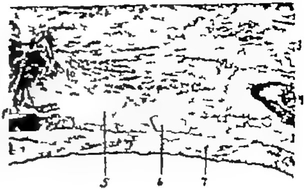


Fig. 1420. Same as preceding showing greater magnification of the two final turns of suturing.

Fig. 1421. Same as preceding, high power magnification. [illegible] Serosa and muscularis of stomach. (6) Capsule of liver, underlying very early organization, which is agglutinating the falciform ligament to the serosa. (7) Falciform ligament.

line used in perforated gastric or duodenal ulcers, or to cover anterior gastrojejunostomy suture lines or in tuberculous gastroenterostomy (Figs. 1419-1420-1421).

CLOSING THE INCISION

The important desiderata in closing the abdomen are:

Snug union of related structures (peritoneum to peritoneum, fascia to fascia, etc.)

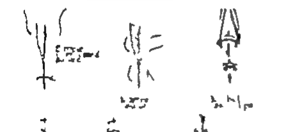


Fig. 1422. Methods of Suturing.

Avoidance of loss of hemmed structures and dead spaces.

3. Avoidance of infection.

Infection on one or a combination of the above postulates predisposes

to hernia. To accomplish secure abdominal closure, a variety of methods have been suggested; however the simpler the method, the better. My preference in closing the abdominal wound is as follows:

Step 1. Pack off the protruding bowels with lap sponges. Engage the edges of the peritoneum with artery forceps; the whole length of the opened peritoneum should be plainly in view. Leave nothing to chance.

Step 2. A full length catgut No. suture carried on a half curved Mayo needle is used to close the peritoneum with a continuous suture. Most surgeons use a continuous suture; yet, I have seen Prof. Gemelli of Trieste, Italy use routinely interrupted sutures in closing the peritoneum. A tablespoon in the abdominal cavity can be used to advantage to keep protruding bowels

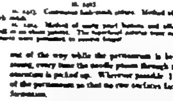


Fig. 1423

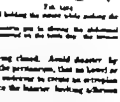


Fig. 1424

Fig. 1423. Continuous lock-stitch suture. Method of holding the suture while making the lock stitch.

Fig. 1424. Method of using pearl buttons and silkworm gut in closing the abdominal wall in an obese patient. The interrupted sutures were removed on the tenth day, the buttons remained some time longer.

out of the way while the peritoneum is being closed. Avoid disaster by seeing, every time the needle passes through the peritoneum, that no bowel or omentum is picked up. Wherever possible I endeavor to create an eversion of the peritoneum so that no raw surfaces face the interior, lessening adhesion formation.

Step 3. Approximate the rectus muscle with one or two interrupted sutures.

Step 4. Close the fascia in the same manner as the peritoneum. The suture may be either interrupted or continuous. I prefer interrupted sutures.

Step 5. The skin may be closed in a number of ways (Figs. 1425-1427):

(a) Interrupted sutures of silkworm gut, continuous sutures of silk or dermal (fiber sutures).

(b) Subcuticular (Halsted suture) (Fig. 1426); here esthetic factors have to be considered.

(c) Michel clips (Fig. 1427).

Tension sutures are used in obese persons. These embrace the entire thickness of the abdominal wall except the peritoneum (Fig. 1424).

Step 6. Cleanse the surface of the abdomen with peroxide of hydrogen. *Apply dressings.*

In obese persons particularly, pearl buttons and silkworm gut are frequently resorted to. The illustration (Fig. 1404) shows the manner in which these buttons are threaded with silkworm gut and their respective positions after the sutures are tied.

Benj. I. Golden[1] states that all wounds heal better when left open to the air and also that gauze has a tendency to adhere to the serous exudate of a fresh wound resulting in irritation and inflammation.

He devised a shield (Figs. 1405–1406) of copper screening, 14 mesh size, which is cut about one inch longer than the wound, and 3 to 3½ inches wide.

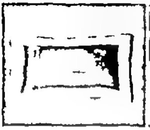


Fig. 1405. Copper screen shield prepared for application. (Courtesy of Dr. B. I. Golden.)

Fig. 1406. Copper shield in position over a clean surgical wound. (Courtesy of Dr. B. I. Golden.)

Bias tape is stitched around the edges, to protect the skin from the sharp edges of the cut screen. The shield is taken in both hands, and the thumbs are used for pressure on the central part molding it so that the central portion is about one-half inch deep and the outer edges remain flat. After being sterilized, it is applied to the abdomen and held by two or three strips of adhesive.

This shield holds the bed clothing away from the wound and permits air to circulate freely. Golden observed no infection at the edges of a clean wound healed rapidly. The shield affords the patient much added comfort. Since the wound is visible at all times there is no necessity for redressing until the sutures are to be removed. The shields are economical and may be used many times.

Comment. Kocher believed silk to be the sovereign material for suturing. In certain cases, silver wire is used (vide infra). Too much time is often spent in closing the abdomen in patients who have undergone serious intra-abdominal procedures or in whom emergency operations have been performed. The condition of the patient is the best index in this connection. The young surgeon should remember that it is better to have a live patient with a postoperative hernia than a cadaver with a meticulously closed abdominal wound.

[1] The Amer. Jour. of Surg., Jan., 19[illegible].

SUTURING, SUTURES AND LIGATURES

Suturing or surgical stitching means the sewing together of the edges of a wound or other solution of continuity of tissues so as to facilitate the reunion of these tissues.

Historical Notes. Before the tenets of asepsis became established, the closing of wounds was considered very hazardous. Sutures as the sewing material were implanted in the tissues of the patient and mortality was high (anthrax, tetanus, erysipelatous infections, gangrene, etc.). The surgeon of old, however, realizing the necessity for controlling hemorrhage and closing wounds, continued to use suture materials, many of which are still used (silk, linen, wire and catgut).

In 600 B.C. Susruta, an Indian surgeon and founder of a system of medicine that bears his name, recommended in his "Compendium of General Medicine" that cotton, strips of leather, fiber from the bark of trees, plaited horsehair and animal sinews be used for suturing and ligating. Celsus referred to the ligating of blood vessels to arrest hemorrhage indicating that the practice was not new in his time.

Galen was the first to identify catgut with surgery. In his "De methodo medendi" he recommends ligating a large strongly pulsating vessel in two places and excising the intervening portion. If silk threads are not available, he says, "choose from the material where you are living the least putrescible such as thin catgut which quickly falls from the vessel." Although twisted gut strings had been used for musical instrument strings centuries before, this is the first known reference to it as a ligatory material.

"Catgut" is the name applied to cords twisted from sheep intestine. The general explanation is that the word was derived from the term "kitgut" or "kitstring," the cord or string used on a "kit" or fiddle; this term became confused with "kit" meaning young cat and in this way the word "catgut" was coined.

The first intestinal suture recorded is described in the Ayur-Veda (2nd century A.D.) which states that after the edges of the wound were drawn together "large black ants" were permitted to bite through the joined tissues; after the mandibles were locked the head of the ant was cut off and left in place. Certain Algerian tribes practiced this procedure as late as 1845.

Paulus Aegineta (7th Century A.D.) records that human hair as well as horsehair was employed for suturing. Hieronymus Fabricius ab Aquapendente preferred gold wire because it "is durable and does not rot and seals the closed parts." He also used linen thread treated with gum tragacanth.

Ambroise Paré revived the practice of ligating bleeding vessels instead of cauterizing them after amputating a limb, as was the custom of the time.

Dr. P. S. Physick is given credit for re-introducing catgut. In 1816 he suggested animal ligatures in place of linen or silk because the latter remained in the wound too long (the direct relation between non-sterile sutures and ligatures with their ends emerging from the wound with the mortality rate resulting from the infection of clean wounds). Dr. Physick's observation of the action of wound discharges in destroying leather straps and his experiments with buckskin ligatures in animals are illuminating. He also experimented with kid, parchment, varnished leather, tendon and intestines of fish as well as catgut. In 1840 Largs Porta reported on a series of animal experiments that showed catgut to be the strongest and most homogeneous substance for ligatures.

Joseph Lister's "Observations on Ligature of Arteries on the Antiseptic System" in 1869, yielded important deductions. Silk threads steeped in a saturated aqueous solution of carbolic acid were used. In one experiment Lister arrived at two important conclusions, viz., the use of sterilized ligature and suture material, and the burying of the ligatures in the wound with the ends cut short. Later continued his suture studies in connection with his historical work in antiseptic and aseptic surgery and decided that excess water was harmful to surgical catgut and the use of chromic acid made catgut more resistant to absorption.

A ligature means a thread which is used in surgery to tie or bind a blood vessel so as to prevent hemorrhage. When other tissues are bound around for any purpose whatever, the material used for such binding is also called a ligature.

The main surgical principle underlying suturing is to keep the different layers of tissues in apposition until by normal processes the divided surfaces have again become continuous and united. In the present accepted methods of surgical technic, suturing is considered to be the best method of accomplishing this purpose; but there are other methods of effecting such union than by stitching. With these we are not concerned in this chapter.

In the closure or reuniting of any separated tissue, a most important thing to remember is tension, or the tendency of such separated surfaces to remain detached or even to increase the distance between them. Such tension differs in different regions. In the abdomen it is very great and particular attention must be paid to overcome and check it. In the extremities, the tension between separated tissues is much less. Again, tension varies with the depth of the wound and with the elasticity of the particular layer of tissue the edges of which have to be sutured.

Suture Material

Regarding the *suture material, it may be absorbable or nonabsorbable.* By an absorbable suture is meant one that is digested or chemically decomposed during the healing process by the tissues in which it is embedded. By such time as the suture has entirely disappeared, the separated tissues which it has held together should have united firmly. The most commonly used absorbable suture materials now in use are catgut and kangaroo tendon. Non-absorbable sutures are not absorbed or decomposed by the tissues and it is necessary that the surgeon remove them when the wound has healed. Wire, silk, silkworm gut, linen, horsehair and various special preparations are used as non-absorbable suture material. They are mostly employed for the superficial tissues.

Selection of Proper Suture Material

The fundamental principles governing absorbable sutures are:

1. That the suture material can be readily and efficiently sterilized.
2. That it will not be absorbed before the tissues it holds together will have had time to unite firmly.

Absorbable material (catgut) is the most generally accepted and is universally used throughout the surgical world. For bone work and where heavy tension has to be met kangaroo tendon or silver wire is mostly employed, the former has a slow rate of absorbability.

1. Sterilized catgut should be used for the ligature of blood vessels and for deep sutures (i.e., those beneath the skin layer) in all operations where the area of operation is already septic.
2. Sterilized catgut should be used for the ligature of blood vessels and for deep sutures wherever the tissues involved are the seat of frequent or extensive involvement.
3. Sterilized silk, linen, the various types of cotton thread or Pagenstecher's celluloid thread, of suitable thickness may be used for the ligature of blood vessels and for deep or so-called buried sutures and ligatures in all operations where the field of operation is aseptic.
4. Silkworm gut of suitable thickness and length should generally be used for the closure of skin wounds with a few exceptions, such as the use of horsehair for the face and fine silver wire in certain cases of cleft palate.
5. Silver wire or aluminum covered copper wire of suitable thickness should generally be used for the approximation and fixation of bones, such as in the operations for fracture of the patella or of the long bones of the limbs. Vitallium bronze-wire has given too much satisfaction in the union of bones. Other surgeons use it by preference (St. Jacques).

It is advantageous to use the smallest possible sizes of catgut sutures compatible with the mechanical conditions of good suturing. *The advantages of using small sizes are:*

1. They cause less trauma to the tissues at points of insertion than do large sutures.
2. They are less irritating to the tissues because they consist of less collagen, and therefore a smaller amount of foreign protein is presented to the tissues for digestion.
3. They permit smaller knots, and so constitute less of a foreign body.
4. They are less likely to be tied under excessive tension and, consequently, to interfere with circulation or cause necrosis of strangulated tissues.
5. They also permit better approximation of tissues.

One cannot definitely specify the sizes and kinds of sutures to be used in the tissues involved in various operations unless a complete description of the nature of the operative procedure is furnished. The same kind of tissue when involved in different types of operations may require an entirely different size and kind of suture. But in a general way the following outline proves efficient.

Appendix (ligation of)—No. [illegible] or No. [illegible] plain catgut.
Appendix (purse-string suture)—No. 00 Pagenstecher linen or No. [illegible] chromic catgut (10-day).
Arteries—No. [illegible] to 000 black silk.
Arteries (ligation of)—No. [illegible] or No. [illegible] plain catgut for small; No. [illegible] chromic catgut (10-day) for large arteries.
Cervix uteri—No. [illegible] or No. [illegible] chromic catgut (20-day).
Eye (canthal ligament)—No. 000 plain catgut.
Eye (conjunctiva)—No. [illegible] black silk.
Eye (lid)—No. [illegible] black silk.
Eye (muscle)—No. 000 chromic catgut (10-day).
Fascia—No. [illegible] chromic catgut (20-day).
Muscle—No. [illegible] plain catgut.
Nerves—No. [illegible] black silk.
Perineum (lacerated)—No. 3 chromic catgut (20-day).
Peritoneum—No. [illegible] plain catgut below the navel. No. [illegible] chromic catgut (10-day) in the upper abdomen because of the layer of deep fascia.
Prepuce (circumcision)—No. 00 or No. [illegible] plain catgut.

Rectum—No. [illegible] or No. [illegible] chromic catgut (20-day) or silk.
Skin—Small wounds, No. 000 or No. 00 silk or linen.
Large wounds, No. 00 or No. [illegible] non-absorbable suture, silk or linen.
Skin (plastic)—No. [illegible] silk or linen.
Stomach and Intestines—No. [illegible] chromic catgut (20-day) or linen.
Subcutaneous fat—No. 00 or No. [illegible] plain catgut.
Tendons—No. [illegible] or No. [illegible] chromic catgut (20-day) or silk or linen.
Tension Sutures—For most situations, No. 1-3 silk or linen or silkworm gut.
Vagina—No. [illegible] or No. [illegible] chromic catgut (20-day), reinforced with tension sutures; also, silk or linen.

STERILIZATION

Sterilization of suture materials can of course be carried out by the surgeon himself if he does not wish to depend upon the assurance of others in regard to this necessary procedure. In practice, however, the preparation of sterilized suture material is left to commercial firms who have specialized in this kind of work. There are several such companies whose products are quite reliable as far as known methods of sterilization and absolute care and efficiency in their application are concerned. Nevertheless, it is questionable if, from the nature of the material (animal tissue) itself, it can be asserted with absolute certainty that catgut can be rendered completely sterile. More assurance can be given in the case of silk, linen, wire and other suture material, and on this account many surgeons prefer to use the latter materials whenever possible (John Erdman). But on the whole, the use of commercially prepared sterilized catgut sutures is quite satisfactory. They are put up in sealed glass tubes. Many surgeons prefer to sterilize the exterior of suture tubes by boiling or autoclaving. The terms "boilable" and "non-boilable" when applied to sutures refer entirely to the process devised in sterilizing the exterior of the sealed glass tubes in the hospital; the exterior of the tube is not sterile and the sterile suture material within may become contaminated when it is removed from the tube. The essential difference between boilable and non-boilable catgut is in the fluid used inside the tube. Catgut tubed in solution containing moisture (water) remains soft and pliable. The boilable catgut is tubed in fluid containing absolutely no moisture (water). The removal of water from the boilable variety of catgut sutures and kangaroo tendons decreases their pliability so that they are slightly stiff when removed from the tube and must be moistened with sterile water to restore their pliability.

When removing boilable sutures from the germicidal solution the tube is broken in a sterile towel and the suture removed with sterile forceps or sterile gloved fingers. Non-boilable sutures should be used immediately after removal from the tubes, but if this is not practicable the sutures are at once placed between folds of a sterile towel wet with ethyl alcohol (95%) wrapped in a piece of sterile rubber dam until the surgeon is ready to use them.

There are a number of methods in use for restoring pliability to boilable catgut sutures, the principal of which are:

Immersion in 70% alcohol; exposure to a towel moistened with 70% alcohol; immersion in saline solution or exposure to a towel moistened with it. In the case of boilable kangaroo tendon sutures, they should be softened by soaking in sterile physiologic saline solution at about body temperature.

Absorption of Suture Material

The period of time required of catgut sutures to become absorbed depends upon their size, whether plain or chromicized, and very particularly upon the condition of the tissues in which they are introduced. The time of absorption specified on the label of the manufacturer applies only when the sutures are in normal tissues of aseptic wounds.

The following "Don'ts" or cautions, should be observed in the handling of ligatures in the hospital:

1. Never touch a sterilized tube with bare fingers. Use sterilized forceps or gloved hand.
2. Never handle catgut or other suture unnecessarily—*it is easily contaminated.*
3. Never attempt to boil tubes marked non-boilable. If you do, the catgut will shrivel, disintegrate and, therefore, become useless.
4. Never place boilable catgut tubes in the sterilizer without first wrapping them in a towel; *they will either float or come in contact with the flame exposed bottom of the sterilizer and glass break.*
5. Never pass hot tubes rapidly through cold air or attempt to open them while hot. Sudden changes in temperature may cause them to explode.
6. Catgut should not be permitted to come in contact with the skin edges of the wound during its use in the deeper structures.
7. Local pus infections anywhere in the body may cause bacteremia. Large quantities of catgut, or tissue strangulated by catgut, may readily favor localization of micro-organisms. This should be borne in mind when condemning catgut as the sole source of infection.
8. Catgut must be digested and absorbed by the tissues; if these are weakened, they should not be over burdened.
9. Catgut absorbs at an inverse ratio to the surface area. For instance, two small strands will ordinarily absorb more quickly than one large strand.
10. Fewer ligatures and a more carefully controlled technic of suturing will tend to accomplish the desired result (perfect union of tissues) and furnish less foreign proteins for the tissues to cope with.

In order to strengthen the resistance to absorption, catgut sutures may be subjected to a process of tanning and are then known as "chromicized sutures." Another advantage of this is that the sutures can be used in smaller sizes for the purpose of maintaining apposition of wounds, since their absorption is much slower than that of plain catgut under the same circumstances.

Needles

Fully curved, half-curved and straight surgical needles are used. The curved types are used for deep wounds and those difficult of access; straight needles are generally employed for superficial wound edges. Needle holders are used for curved needles (Fig. 1427).

Dr. [illegible] described an "[illegible]" suture (J.A.M.A., June [illegible]). This is an ingenious holder which [illegible] the needle and ties the knot automatically [illegible] cuts off the ends of the suture and [illegible] of marked advantage in all forms of so-called minor surgery (Fig. [illegible]).

Types of Suture

Sutures are further classified, according to the manner in which they are inserted in the tissues, as interrupted, continuous and tension sutures (Fig. 1428, p. 1396). The actual method of putting in these or other sutures correctly is a part of the surgical student's practical education.

Fig. 1427.—Needle holder.

Interrupted sutures are inserted in the tissues in such a manner that each stitch is self-contained and tied independently of the other stitches.

Continuous sutures are inserted so as to consist of a series of stitches, the suture running continuously from one stitch to the other and only the first and last of the series are tied.

Continuous Lockstitch. L. Torrance finds the advantages of a continuous lockstitch in closure of wounds over the simple, continuous suture. The technic is shown in Figs. 1429-1430-1431.

A tension suture is a non-absorbable suture inserted at a distance from the incision and passed through the skin, subcutaneous tissues, fascia and muscle. A tension suture is not used to approximate tissues, but only to support the tissues and thus aid the rapidity and soundness of the process of repair.

Small "bites" of tissue should be taken and tying performed with the least amount of tension. Undue tension causes necrosis of the tissues by constricting circulation of the healing parts. Edges of tissues which cannot be approximated

Fig. 1428.—Method of [illegible] suture. A, needle on hook threader; B, needle and catgut on hook threader; C, needle threaded; D, threaded needle making buttonhole knot for anchoring; E, needle held and [illegible] needle anchored; G, suture in use.

by light traction ought not to be sutured. Above all, it is wise to adopt the rule "only to approximate and never to strangulate."

A factor of safety in a laparotomy wound can be provided by placing tension

sutures at a distance from the incised area, thus putting the strain on healthy tissues. For example, after suturing the peritoneum, interrupted, non-absorbable tension sutures may be inserted through the skin, subcutaneous tissues, fascia and muscle on one side, and passed up through these same structures on

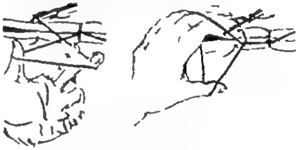


Fig. 1429. Fig. 1430.

Fig. 1429.—[illegible] continuous lock stitch. [illegible]
Fig. 1430.—Torrance continuous lock stitch. [illegible]

the opposite side of the wound. Then the muscle, fascia and fat are approximated with many small fine sutures of fine catgut. After closure of the skin, the tension sutures should be threaded into small rubber tubes before being tied, or some other means provided to prevent cutting into the skin under tension.

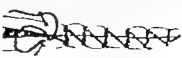


Fig. 1431.—Torrance continuous lock stitch completed.

Knots

It is essential that the surgeon should be quite dextrous in making certain knots which are used in tying sutures and ligatures. Such a knowledge can never be obtained by reading or watching others. The method of making these knots must be acquired by personal instruction and practice and mastered by constant repetition so that the fingers act subconsciously and mechanically in the proper way. The *reef knot* and the *surgeon's knot* are the most commonly employed in surgery. The reef knot, also called the *flat knot* and the square knot, consists of two simple knots placed in such a way that the end of the

same direction through both loops (Figs. 1431-1433). The surgeon's knot is a variation of the reef or flat knot, differing only in that the first hitch consists of a compound knot instead of a simple knot. Its advantages are that when tying down the second hitch on to the first, slipping or sliding of the first hitch does not

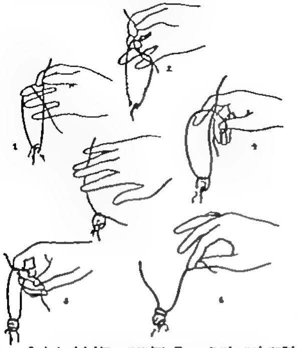


Fig. 1429. One hand method of tying a square knot. The opposite end is merely steadied.

occur and it is less likely to yield before an expanding force within the sutured tissues.

The knot is, perhaps, of more importance in the case of ligatures of an important blood vessel than of sutures. In the case mentioned a stay knot is employed having for its object also to leave as near as [illegible] of the lumen of the vessel as possible. Two separate ligatures are passed around the vessel, parallel to each other and side by side; the first hitch of a reef knot is tied in each ligature separately. Then the two ends are picked up on each side and these double ends

are tied as one into a simple knot after the manner of the second step of the reef knot.

Closure of a wound by continuous suture is best for bringing the margins of a wound into good approximation and keeping them so, but there is a disadvantage in continuous sutures in that if one part cuts out the approximation of the whole line is imperilled. According to the circumstances of the particular case it may be

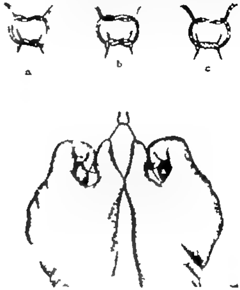


Fig. 1430. a, Square knot, flat or reef knot; b, granny (false) knot; c, surgeon's knot.

better to close each suture by a reef knot. When silkworm gut is used for closing the external layer of a wound, the best method of closing it is by the first stage of a true surgeon's knot. Never pull sutures too tightly when tying them or they may cut out and an unnecessary amount of scarring result; they should be just tight enough to keep the wound margins in apposition.

Through-and-Through Silver Wire Sutures

Reid, Zinninger and Merrell[1] laud the use of silver wire as a means of closure of the abdomen with through-and-through sutures in cases of acute abdominal emergencies. The method is not new. The entire thickness of the abdominal

[1] Annals of Surgery, Nov. 1933.

wall is embraced in the interrupted sutures (from skin to peritoneum inclusive). The most pliable wire should be used. Reid et al. procure it in one ounce lots which are rolled on a spool. The method is as follows:

Ten- to twelve-inch lengths of virgin silver wire, No. 22 gauge, are threaded on large, curved, cutting edge needles such as are ordinarily used for inserting "stay" or "tension" sutures. The short end is folded back over the eye of the needle and crushed flat with a heavy forceps so the wire will more easily go

Fig. 1434. Through-and-through silver wire suture. (Courtesy of Drs. Reid, Zinninger and Merrell.)

through the hole made by the needle. A clamp is fastened on the free end as is done with silkworm-gut "stay" or "tension" sutures. A series of clamps is placed on the edge of the peritoneum. All the silver wire sutures are then placed but not tied. For each suture the needle is started about one or one and a half inches from the edge of the incision and carried through the entire thickness of the abdominal wall, including the peritoneum. The suture is continued by bringing it out at a corresponding place on the opposite side of the incision. It is important that no kinks be allowed to get in the wire during this step as they are exceedingly difficult to get out smoothly. The needle is unthreaded and a clamp placed on the free end of the wire. A series of such sutures is placed about one and one-quarter

to one and one-half inches apart, five to eight being used to close the average incision. After all are placed, the clamps on the peritoneum are removed and the incision closed by pulling up and twisting each wire individually. Beginning at one end of the incision, the surgeon pulls up on the clamps at opposite ends of one suture. The first assistant puts a finger inside the abdomen and reports when the wire is pulled sufficiently tight to bring the peritoneal edges in firm contact. The wire is then twisted six to eight times just above one of the openings through which it emerges from the skin—not over the line of incision. Each wire is pulled up in succession and twisted (Figs. 1434-1435-1436-1437). It is extremely important that the desired tension be obtained before the twisting is started because the twisting is for the purpose of holding only and will not tighten the suture nor remove any slack in it. After all the sutures are tied in this way one or two

Fig. 1435. Diagram showing position of the wire and dressings of the wound after closure. (Courtesy of Drs. Reid, Zinninger and Merrell, Annals of Surgery.)

silk stitches may if necessary be placed in the skin between each two wires to prevent eversion or inversion of the skin edges. The wires are cut rather long so they are easier to manipulate in the dressings if an inch or more of straight wire is free beyond the twisted part. No rubber tubing or other material is placed about the wires where they cross the incision or between the wires and the skin. There is usually some cutting of the skin under the wires before they are removed, but this has never constituted a serious complication of wound healing. Various modifications have been tried in an effort to prevent this cutting of the skin, but the method just described has been more satisfactory than any of the modifications. This entire procedure can be carried out in only a fraction of the time necessary for a formal closure of the incision in layers.

It is also possible by this method to close a wound which is under considerable tension or one in which the peritoneum fails to hold sutures but tears with each attempt to pull it together. The method is very valuable in all cases in which there is likelihood of infection.

While rupture of the abdominal wound in cases of gunshot wound of the abdomen occurred four times in the past year (1933), no case of rupture of an incision closed by silver wire during ten years was observed by Reid and his associates.

A separate closure of the peritoneum where this method is used is not necessary.

Objections and disadvantages of the method:

1. Patients, almost without exception, complain of pain in the incision. Silver wire is more stiff than other suture material hence causes more discomfort.
2. There is usually some infection around the wire which may be removed and the incision itself heals without infection. It is rare to have no discharge from the wire holes, although this is no greater than that which occurs around other types of "tension" or "stay" sutures in the same kind of cases.
3. There is usually some cutting of the wires into the skin, causing skin [illegible] cross-hatching of the incision (patients with tendencies to keloid formation may develop disfiguring scars).
4. The theoretical objections of incomplete closure of the peritoneum predisposing to hernia and obstructive intra-abdominal adhesions have not been borne out in fact.
5. Reid et al. have never seen [illegible] slough of the tissue enclosed by the sutures.

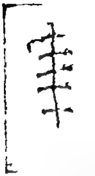


Fig. 1426

Fig. 1427

Fig. 1426. Photograph of wound five days after closure with silver wire.
Fig. 1427. Photograph of wound several months after [illegible] silver wire sutures. (Courtesy of Drs. Reid, Zinninger and Merrell, Annals of Surgery.)

ADVANTAGES

1. Secure closure. In spite of severe infection, Reid observed no case of postoperative rupture of the incision and no evisceration. In two cases of the 334 reviewed a loop of bowel or bit of omentum slipped out between the wires which were too far apart or not sufficiently tight. One additional case of this sort occurred in 1933 which is not included in this series.
2. The closure can be carried out very rapidly. This is obviously very advantageous in critically ill patients when speed of procedure is imperative.

3. The method may be used to close an abdomen under tension (cases of intestinal obstruction) when other sutures fail to hold.
4. The incision thus closed can be easily reopened by untwisting the wire in case a second operation is deemed advisable shortly after the original procedure. In such contingency the wires can be pulled aside, the necessary procedure carried out, and the wires pulled up and retwisted.
5. In cases of peritonitis or potential infection (perforation of a hollow viscus) the closure with interrupted sutures allows peritoneal exudate to drain off between the sutures—no additional drains being necessary. The absence of suture material directly in the line of closure of contaminated incision predisposes to better wound healing and reduces the liability to infection.
6. The closure is so secure that old and debilitated patients derive the benefit of leaving the bed early (five to seven days after operation).
7. The incidence of postoperative ventral hernia is no greater than after other more formal types of closure in the same types of cases, so far as *Reid* has been able to determine, and in his series of cases where silver wire was used no evisceration occurred.

Fig. 1428. Hypertrophy of the abdominal wall.

Silver wire sutures used in this manner are ordinarily removed about sixteen to eighteen days after operation. If found too tight at any time, they can be loosened by untwisting them, allowing a little slack to be taken up by the wound, and retwisting them. Reid et al. study of statistical data showed that the shortest time before all sutures were removed was ten days, and the longest any were allowed to remain was thirty-seven days. Ordinarily part of the sutures are removed about the fifteenth or sixteenth day and the remaining ones the seventeenth or eighteenth day, though at times all of them are removed at one stage.

Postoperative Rupture of Abdominal Wounds and Evisceration (Eventration).

Postoperative rupture of abdominal wounds often results from an inadequate closure of the peritoneum. Omentum and occasionally bowel forces itself between the loose sutures and in swelling acts as an expanding wedge which forces the tissues apart and prevents proper union, the process being aided by severe coughing or, perhaps, suppuration. A rupture may then be precipitated by the strain of vomiting or distention, especially when the fascia is involved. Massive adhesions and many postoperative hernias are similarly explained.

The late J. F. Baldwin of Columbus, Ohio, believed that too early removal of

the sutures is often responsible for postoperative eventration. It is also my belief that sutures are removed too soon. My practice is to remove abdominal wound sutures routinely on the eleventh day after the operation. Baldwin extended this period to fourteen full days routinely. At the end of fourteen days, should trouble be found in the wound, inflammation or suppuration, Baldwin counseled leaving the sutures in situ "until it is evident that all danger is past." To forestall eventration, he closes the peritoneum with a continuous suture of chromic catgut No. [illegible]. The adjacent edges of the recti muscles are whipped together with another stitch and the aponeurosis closed with a third similar suture. Silkworm gut stay sutures are then inserted which take in the rest of the abdominal wall, no matter how thick, each stitch catching the preceding rows of catgut sutures down to and including a part of the rectus muscle. The skin is approximated by

Fig. 1429. [illegible] of skin [illegible] fat [illegible] removed [illegible] author's [illegible] sutures for abdominal lipectomy on patient shown in the preceding illustration.

a continuous catgut suture. It is these stay sutures that are removed at the end of fourteen full days, or later as judgment may suggest. Since this procedure has been adopted, out of not less than 3,000 abdominal sections there has not been a single instance of eventration.

Often have I heard Dr. Karl Meyer comment on the hurried removal of sutures by interns alarmed at a serosanguineous discharge from the wound, when, as a matter of fact, this very discharge is a signal denoting an approaching disruption of the wound which should cause us to insist that the sutures be left alone and that their removal is sure to be followed by the very thing we are seeking to avoid.

OPERATION FOR PENDULOUS ABDOMEN

(Lipectomy—Adipectomy)

Often women develop enormously large pendulous abdominal walls (Fig. 1428). The skin and subcutaneous fat layer may become so disproportionate as to form a veritable "apron" in front of the thighs. German writers refer to the condition as "Hängebauch" (pendulous abdomen). This fat-apron may contain from 10,000 grammes of fat, or even more (Fig. 1430). Such conditions may often become trying to the patient. Besides the weight, intertriginous conditions

Fig. 1430. [illegible]

Fig. 1431. Hypertrophy of the abdominal wall. Author's [illegible] method of removing the apron [illegible] of fat [illegible]. Wrong method of making incisions [illegible] proper approximation of the [illegible] One [illegible] the [illegible] thickness of the fat layer and [illegible] portion of the fascia [illegible]. The skin [illegible] by interrupted sutures.

are apt to develop rendering the patient very uncomfortable. The condition is remedied by excision of the excessive cutaneo-adipose segment of abdominal wall.

Step 1. A transverse incision depicted in Fig. 1440 has seemed to me to be best in this class of cases. The transverse crease usually present above the symphysis pubis is a good landmark for the lower incision to follow.

Step 2. Use a sharp knife. Carry the upper and lower incisions down to the fascia obliquely so that they meet at the fascia (Fig. 1441). If the incision is made perpendicularly an exposed area of fascia results which, in order to be effectually covered, requires the undermining of the fat above and below in order to properly approximate the edges of the wound. This should be avoided because it often results in fat necrosis and breaking down of the wound. Hemostasis must be meticulous and sponging of the exposed surfaces gentle.

Step 3. For tension sutures, which embrace the entire thickness of the panniculus, the button suture described under "Closure of the Abdomen" Fig. 1402, p. 148, or interrupted silkworm gut sutures should be used. The skin may be united with clips or interrupted silk or Pagenstecher linen sutures. Where tremendous areas has been ablated or where undue operative trauma was inflicted it is prudent to insert at each angle of the wound a wick of silkworm gut strands or a small cigarette drain which are to be removed after a day or two. Avoid dead spaces by obliterating irregular surfaces by interrupted catgut sutures.

Comment: This operation gives excellent results so long as the musculo-aponeurotic wall is not greatly tensed. If so, these should be reinforced. Adiposity does not recur in the area operated upon.

CHAPTER 33

SURGERY OF THE STOMACH

Historical Notes. Gastrotomy was proposed by Egeberg in 1837 and first performed by Sédillot in 1849.

Gastro-enterostomy.—(a) Anterior gastro-enterostomy (Wölfler's Operation) was suggested by Nicoladoni and first performed by Wölfler in 1881. (b) Posterior gastro-enterostomy (von Hacker's Operation) was suggested by Courvoisier in 1883 and performed by von Hacker in 1885. Gastroduodenostomy was done by Jaboulay in 1892. Gastro-enterostomy (Roux Operation) was done by Roux in 1897. Pyloric exclusion in conjunction with gastro-enterostomy to forestall vicious circle, was done by Doyen in 1893 and by Eiselsberg in 1895.

Jejuno-jejunostomy (Braun-Jaboulay) in conjunction with anterior gastro-enterostomy was done by Braun in 1892 and followed later by Jaboulay.

Pyloroplasty (Heineke-Mikulicz Operation) was described by Heineke in 1886 and by Mikulicz in 1887.

Finney's Pyloroplasty or gastroduodenostomy was published in 1902.

Pylorectomy was suggested by Gussenbauer and Winiwarter in 1876 (experiments on dogs). The first pylorectomy was done by Péan in 1879 and by Rydygier in 1880. The first successful pylorectomy was done by Billroth (Billroth I) in 1881.

Partial gastrectomy was introduced by Billroth (Billroth I) in 1881 and the Billroth II (closure of the divided duodenum and stomach supplemented by gastro-enterostomy) in 1885.

Reichel Operation of Implantation of the open stomach into the jejunum was performed by Reichel in 1908. Pólya described the same operation in 1911. Reichel and Pólya's procedures were retrocolic. Balfour's modification of the Reichel Pólya operation (1917) consists of an antecolic anastomosis supplemented by an entero-entero-anastomosis. Moynihan's modification of the Reichel Pólya procedure was reported in 1920 and consists of a short loop antecolic anastomosis without entero-entero-anastomosis (Moynihan II). The Moynihan I modification is essentially as follows: Gastric resection. Division of a long loop of jejunum, the efferent loop of which is anastomosed with the stomach while its afferent opening is anastomosed with its lateral surface. The operation is retrocolic. In the Hofmeister-Finsterer operation only the lower portion of the gastric opening is utilized for the implantation of jejunum.

Total gastrectomy was first performed by Connor of Cincinnati, 1884. The first successful total removal of the stomach was done by Schlatter in 1897.

Choledochogastrostomy was done by Babcock in 1924.

Types of Gastric Operations (after G. Cosma).

Gastrectomy

A. Partial

B. Subtotal or Total.

Typical Resection

Pylorectomy

Midgastric resection (Riedel)

3. Fragplastic (Finsterer)

4. Pyloroantrectomy (Gastroduodenal resection).

Atypical Resection

Resection of the Lesser Curvature (saddle-form, cuneiform, longitudinal, falciform, disc-shaped, etc.)

Gastric Resections and Gastroduodenostomy Operations (Péan-Billroth I).

Termino-terminal: Péan (1879), Rydygier (1880), Billroth (1881) (typical pylorectomy).

Variations: Campel (1903), Hanley (1908), Babcock (1908), Haberer (1927) with resection of lesser curvature. Schmieden (1921), Leopert and Fenchel (1923), Schoemaker (1909).

2. Posterior Latero-terminal: Kocher (1893).

Anterior modifications.

Kausche-Lieberg (1923), Pétersburg (1930).

3. Termino-lateral: Haberer (1921), Finsterer (1923), Winkelbauer (1927).

4. Latero-lateral: Alapuzzin-Olliard (1924), Lerche (1927).

Gastric Resections with Gastrojejunostomy Operations (Billroth II).

Anterior precolic: Billroth II (1885, atypical pylorectomy) (Schlatter operation on "Y" 1913).

Retrocolic: Dahlberg (1898).

2. Latero-lateral—Posterior—antecolic: Eiselsberg (1899), retrocolic: Braun (1894), Hacker (1894).

Marginal: Mikulicz (1887).

3. Latero-terminal—Posterior—retrocolic: Roux's operation on "Y" (1897).

4. Termino-terminal—Retrocolic: Rydygier. Operation on "Y" (1904). Moschcowitz (1908) Braun (1911).

5. Termino-lateral—Total Antecolic—Krönlein (1887). Balfour. Moynihan II.

Retrocolic: Reichel (1907), Pólya (1911), Sapir (1912), Moynihan I.

Partial: Inferior stoma suggested by Hacker (1885), antecolic: Eiselsberg (1888), Cosma: Operation on "Y" (1909).

Retrocolic: Hofmeister (1909), Wilms (1911), Finsterer (1914).

Superior stoma: Schmieden (1921).

Anatomic Considerations. The Orifices of the Stomach. The cardiac orifice of the stomach is situated opposite the tenth dorsal vertebra in a position about half an inch to the left of the midline and three or four inches behind the tenth left costal cartilage. The pyloric antrum leads to the pyloric canal which terminates in the pyloric orifice. The latter normally admits the tip of the little finger. The patency of the orifice may be ascertained by invaginating the finger through the anterior wall of the stomach.

The Sphincters of the Stomach. (1) The cardiac sphincter (G. G. Sheltack) consists of a fairly widespread thickening of the circular muscle of the lower end of the esophagus and the upper part of the stomach. It is definite enough to be called a sphincter. On contraction it gives rise to a cardiac canal rather than a cardiac orifice. The sphincteric arrangement is situated mostly below the diaphragm. (2) The pyloric sphincter plays an important part in gastric digestion.

The Peritoneal Connections of the Stomach

(1) The gastrocolic ligament connects the greater curvature of the stomach with the transverse colon. It continues downward as the two anterior layers of

the great omentum. In it are contained the right and left gastro-epiploic vessels (Figs. 1442-1443-1444-1445).

(2) The lesser or gastrohepatic omentum is attached above to the portal fissure of the liver and partly to the diaphragm. The right free border of the lesser omentum forms the anterior boundary of the Foramen of Winslow (Fig. 1446). It contains in its thick portion (hepatoduodenal ligament) (a) the common bile duct, (b) the portal vein and (c) the hepatic artery. In the gastric attachment of this omentum are situated the pyloric (right gastric) and left coronary (left gastric) arteries.

(3) The gastrophrenic ligament courses backward from the cardiac end of the greater curvature to the diaphragm, and is joined to the posterior abdominal wall by a peritoneal fold known as the gastropancreatic ligament. The latter carries the coronary (left gastric) artery to the cardiac end of the lesser curvature of the stomach.

(4) The gastrosplenic omentum extends from the greater curvature in the region of the fundus, to the hilum of the spleen. It contains the left gastro-epiploic artery and the vasa brevia of the splenic artery.

All of these carry blood vessels, lymphatics and nerves.

Blood-Supply. The blood supply of the stomach is derived from the celiac axis which springs from the abdominal aorta and gives off three branches: (a) the gastric (left coronary), (b) hepatic and (c) splenic arteries. All of these give branches to the stomach (Fig. 1447).

GASTRIC ARTERIES

ARTERIES	SOURCE
Coronary (left gastric)	Celiac axis
Pyloric (right gastric)	Hepatic (Branch of celiac axis)
Gastroepiploica dextra	Gastroduodenal (Branch of hepatic)
Gastroepiploica sinistra	Splenic (Branch of celiac axis)
Vasa Brevia	Splenic (Branch of celiac axis)

GASTRIC VEINS

VEINS	EMPTIES INTO
Coronary (left gastric)	Portal vein
Pyloric (right gastric)	Portal vein
Gastroepiploica dextra	Superior mesenteric vein
Gastroepiploica sinistra	Splenic vein
Vasa Brevia	Splenic vein
Superior vein of Mayo	Pyloric vein
Inferior vein of Mayo	Gastroepiploica dextra vein

The Lymphatic System of the Stomach. (Figs. 1448-1449) A thorough knowledge of the disposition of the lymph nodes is essential, particularly in the treatment of carcinoma of the stomach. The lymphatics of the stomach take origin in two networks: one is situated in the mucous membrane, the other in the muscle. The mucous plexus from within the mucosa passes to the submucous plexus, which traverses the muscular coat obliquely and terminates in the subserous plexus. The latter also receives the lymphatics from the muscular coat; these are only indirectly connected with the lymphatics of the mucosa. It is for

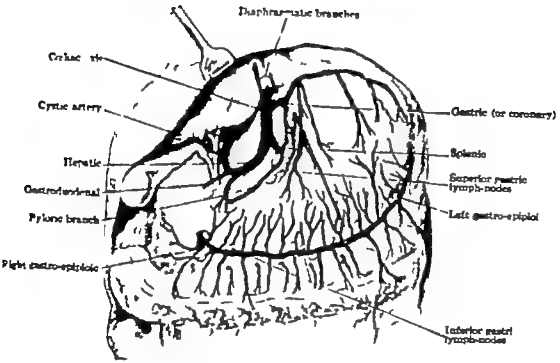


FIG. 1442. Blood supply and lymphatics of the stomach, and Hartmann-Mikulicz line.

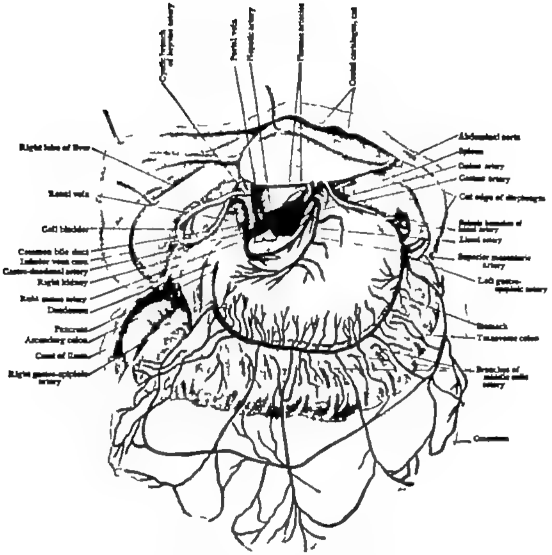


FIG 1447 Stomach and its blood supply (Piersol.)

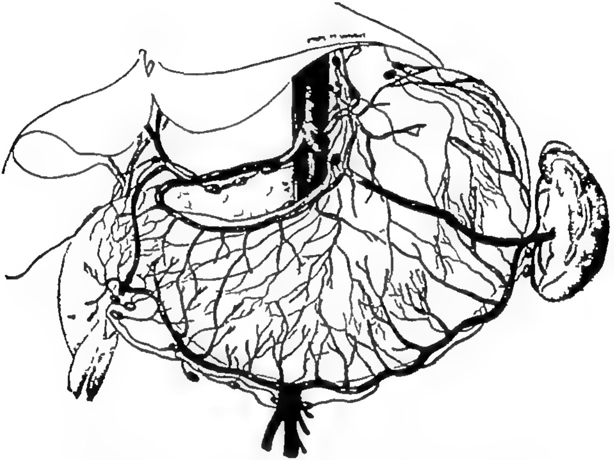


FIG. 1448. The arteries and lymphatics of the stomach. Anterior view. Diagrammatic. (Abdominal Operations Moynihan, W. B. Saunders Co.)

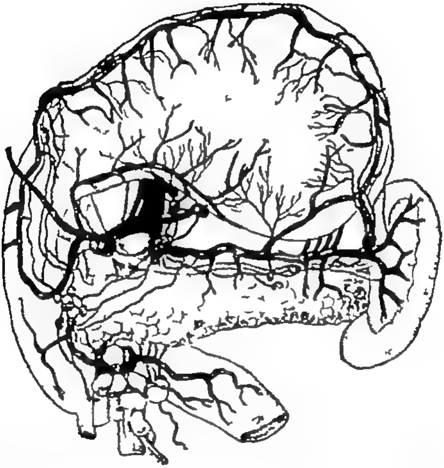


Fig 1449 The arteries and lymphatics of the stomach Posterior view (Abdominal Operations, Moynihan, W B Saunders Co)

that reason that malignant disease of the stomach may be widespread in the mucosa before invading the serous surface.

Practically all of the lymphatics of the stomach drain ultimately into the nodes near the celiac axis. The areas adjacent to the lesser curvature drain directly into nodes on the coronary artery. The areas adjacent to the greater curvature drain into the gastrocolic nodes which in turn empty into the subpyloric lymph nodes.

The pylorus itself drains both upward to the suprapyloric nodes and downward to the subpyloric lymph nodes, (a) along the gastroduodenal artery anterior to the pancreas, to the superior pancreatic nodes, (b) downward in front of the pancreas to nodes lying beside the superior mesenteric artery.

It must be remembered that the celiac axis is retroperitoneal and that the coronary artery in its course along the lesser curvature of the stomach lies in the gastrohepatic omentum, but that that portion of the coronary artery before its inclusion in the lesser omentum lies in the fold coronaria or gastropancreatic fold of peritoneum. Here a number of lymph nodes are to be found and the lymph from the nodes in the lesser omentum drains through these. In operating for carcinoma of the stomach the relation of the subpyloric lymph vessels to the superior mesenteric group of nodes, the suprapyloric of the retroduodenal biliary group and the direct route of drainage from the pyloric region to the nodes in the fold coronaria, is to be kept constantly in the foreground, if success is to be attained.

Carcinoma of the pylorus usually spreads toward the cardiac end of the stomach, particularly along the lesser curvature; therefore, the whole lesser curvature and all suspected lymph nodes should be removed. In removing lymph nodes from the greater omentum there is danger of wounding the middle colic artery. Gangrene of the transverse colon may then result.

The fundus of the stomach is drained by vessels which empty into the nodes along the splenic artery. *While there are some nodes along the greater curvature toward the pyloric end, Cunéo and Poirier are authority for the statement that it* [illegible] rare to find lymph nodes in the middle portion of the greater curvature and quite exceptional to meet them in the region of the fundus.

To summarize it may be said that the stomach may be divided into three lymphatic territories corresponding fairly close to the arterial territories. They may be tabulated as follows:

Hepatic Group—(a) Hepatic, (b) Cystic (c) Subpyloric
Gastric Group—(a) Superior (b) Inferior

The superior nodes are divided into (a) upper along the upper part of the left gastric artery, lower on the lower part of the left gastric artery along the left half of the lesser curvature between the layers of the lesser omentum.

The hepatic nodes are situated along the hepatic artery or its branches, in the lesser omentum along the bile ducts. They drain the liver and gallbladder.

The subpyloric nodes are located in the angle between the first and second part of the duodenum on the head of the pancreas about the bifurcation of the gastroduodenal artery. They drain the right two thirds of the greater curvature of the stomach through the inferior gastric nodes.

3. The pancreatico-lienal group is situated along the splenic artery at the upper

border of the pancreas. There are also some nodes along the vasa brevia in the gastro-splenic ligament.

The efferents from all the nodes course to the lymph nodes of the celiac axis in front of the aorta (the celiac group of preaortic nodes).

Nomenclature. If the pyloric segment is removed, pylorectomy is spoken of. If a larger portion of the stomach is taken away partial or subtotal gastrectomy is the term used, depending upon the size of the segment of stomach ablated. If the midportion of the stomach is removed, midgastric or sleeve resection is spoken of and if all of the stomach is taken away total gastrectomy is the term used.

Gastrotomy or opening of the stomach is performed for the removal of foreign bodies and exploration of the interior of the viscus.

Cardiectomy consists of division of the cardiac end of the stomach and is also known as Mikulicz's operation.

Gastrostomy is the creation of a gastric fistula for purposes of artificial feeding and occasionally for gastroscopy.

Gastroplication consists of folding the walls of the stomach to reduce its size. Gastropexy is suspension of the stomach. Gastro-enterostomy consists of the establishment of an opening between the stomach and the jejunum (gastro-jejunostomy). Finney's operation is a gastro-duodenostomy. Pyloroplasty (Loreta's operation) consists of dilatation of the pylorus.

DIAGNOSTIC OPERATIONS

PERORAL GASTROSCOPY

Jackson and Jackson[1] state that endoscopic examination may be indicated for all diseases of the stomach, though not necessarily for every case.

METHODS OF GASTROSCOPY

There are three methods of gastroscopy—open tube, the lens system and combination of the two. Open tube is required for removal of foreign bodies or of specimens of tissue for histologic examination. Its advantage is the direct examination of tissue and normal size image, and its limitations—a straight and rigid instrument, need of training and skill in use, and limitation of explorable area. Danger lies in serious or fatal trauma of the esophagus unless skill is used and the esophageal lumen ahead is always followed. The lens system has advantage of a larger field of vision with a magnified image. Much of the danger in gastroscopy has been eliminated by the Wolf-Schindler distal half flexible lens gastroscope. *Danger.*—Almost all danger in gastroscopy lies in trauma during the insertion of the gastroscope. The mediastinum or pleural cavity may also be entered, with many possible complications resulting.

NORMAL GASTROSCOPIC APPEARANCES

The color varies greatly even in the normal. The degree of illumination and presence of fluid also disguise the color. Under the open tube gastroscope the gastric mucosa appears deep pink, while the esophageal mucosa is pale, rather bluish pink; it is deeper yellowish pink while passing through the hiatal pinchcock.

[1] J.A.M.A. Jan. 26, 1935.

into the stomach. The lens system rigid instrument shows the esophageal mucosa pale pink, the gastric mucosa pale orange red—a deeper red with the flexible gastroscope.

Form. Folds crowd in on the mouth of the open tube, but may be flattened by pressure. The pylorus is difficult to find, although the general direction of the folds is toward the pylorus.

Movement. The constant gastric movements cause a great variety in the prominence, direction, shape and size of the folds.

NEGATIVE OBSERVATIONS

Through educated gastroscopic vision, negative observations are valuable especially with the flexible gastroscope rotation and repeated examinations. Normal mucosa can be recognized and gastritis or other diffused lesions excluded.

Fig. 1452. Blood and mucus [illegible]

Contraindications

Peroral gastroscopy is contraindicated in patients with cardiovascular disease, with local aneurysm, or with esophageal disease. In the latter case the use of the flexible gastroscope is contraindicated. If not contraindicated and if esophageal obstruction is found, no harm is done and a positive diagnosis can be made.

Indications

In Disease. Unless contraindicated, gastroscopy should be used in diagnosis of every patient with gastric symptoms not as a substitute but in addition to other methods. Gastroscopic examination of an anastomosis [illegible] especially often reveals localized gastritis and ulceration. It is strongly indicated in hematemesis. If no esophageal disease exists a flexible gastroscope may be used. A bleeding point from tubal contact, which does not reappear when wiped away, must not be mistaken for the source of hematemesis. An open tube is better than a flexible gastroscope for detecting blood (Fig. 1452). Also, it is indicated for biopsy in early cancer and breaking down gastritis. In neurotic patients with gastric symptoms, in supposed hysterical gastritis, many times lesions, chronic gastritis or esophageal conditions were found.

For Foreign Body. Indications are (1) the foreign body is too large or the pylorus too small to permit passage, (2) foreign body dangerous to passage through intestine: sharp points or edges, size or toxic (Figs. 1451–1453). (3) foreign body impacted in the suprahiatal or intrathoracic stomach, (4) open safety pins, in certain positions.

Gastritis. Gastroscopy is of great value in making diagnostic work, especially in gastritis, where roentgen ray is least helpful. *Gastroscopic appearances* in the open tube are similar to processes on other mucosal surfaces. The lens system gives a dark red effect—in some cases of gastritis a still deeper hue in

Fig. 1453. Toy watch in stomach of a child, aged [illegible] years, illustrating the indications for gastroscopic removal. [illegible] (From Jackson: Diseases of the Air and Food Passages of Foreign-body Origin, Philadelphia, W. B. Saunders Co.)

Fig. 1454. Safety pin in the stomach of a child, aged [illegible] years, removed through the mouth by gastroscopy. [illegible] (From Jackson: Diseases of the Air and Food Passages of Foreign-body Origin, Philadelphia, W. B. Saunders Co.)

the esophagus, and inspection of the interior of the stomach. Occasionally the surgeon is called upon to remove foreign bodies under dangerous different than

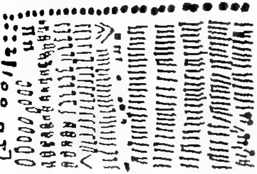


Fig. 1457. Objects removed from patient's stomach.

Fig. 1458. Phytobezoars. Stomach [illegible] ... Fig. 1459. Bezoar in stomach. Stomach [illegible] ... Outline of phytobezoar easily [illegible]

the real cause of the symptoms. In one instance I removed (March, 192[illegible]) [illegible] objects from the stomach of a professional "swallower" (Fig. 1457). The patient recovered.

[illegible] Clinic, Vol. [illegible]

On another occasion a patient was referred to me with a diagnosis of carcinoma of the stomach (Figs. 1458-1459) and at operation two large phytobezoars were removed. In this case a correct diagnosis was made prior to operation (Dr.

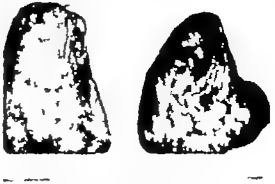


Fig. 1460. Phytobezoars removed by gastrotomy.

Phil Thorek) who elicited in the history that the patient had been eating persimmons to excess (Figs. 1460-1461).

Step 1. Make a vertical incision 4 inches long, about three-quarters of an inch to the left of the midline of the epigastric region. Clamp cloths to the edges

Fig. 1461. Phytobezoars removed by gastrotomy. Split open.

of the skin incision to avoid contamination. Incise the anterior sheath of the rectus muscle. Retract the rectus muscle outward.

Step 4. Incise the posterior layer of the rectus sheath and peritoneum, immediately back of the wound in the anterior sheath.

Step 5. Separate the involved portion of the stomach from the remainder of the peritoneal cavity by means of laparotomy pads. If a large exploratory

wound in the stomach is thought necessary the incision should be made horizontally instead of vertically.

Step 4. *After making an incision in the stomach of the right size and location, remove the foreign body by means of forceps.* Before making the incision, however, insert a[illegible] traction suture through the seromuscular layers just beyond each end of the proposed wound and lift up the line of incision. Locate the foreign body and enlarge the incision sufficiently so that no tearing or stretching of the stomach wall will be necessary in removing it.

Step 5. Close the wound with a row of through-and-through continuous sutures of No. [illegible]-day chromic catgut, pulled tight enough to check bleeding, inverting the edges so that there is no protrusion of gastric membrane.

Step 6. Lay aside all articles that have touched the mucous membrane, put on a fresh pair of gloves, replace the outer layer of laparotomy pads with fresh ones. Insert continuous Lembert sutures with fine Pagenstecher linen.

Step 7. After removing the pads, bring the edges of the abdominal wound together with layer sutures.

No water is given per mouth for 12 hours, but may be administered by proctoclysis. The patient is not fed for one or two days, depending upon the size of the stomach incision, the patient's need for nutrition and the presence of vomiting. This operation is not considered dangerous, if care is exercised so that the peritoneum does not become infected and if the wound in the stomach is properly sutured so that no bleeding or leakage takes place.

GASTROSTOMY

If we consider that the literature discloses more than thirty operative procedures for the performance of gastrostomy one must conclude that most surgeons are not entirely satisfied with the methods in vogue.

The two great pitfalls in gastrostomy as performed today are:

First, it is difficult to render the stomach airtight and consequently egress of gastric contents often causes excoriations and cutaneous ulcerations, which render the patient most uncomfortable.

Second, the difficulties commonly encountered with operations in vogue.

INDICATIONS FOR GASTROSTOMY

Mechanical interference with deglutition from diverse causes.

(a) Carcinoma of the oropharynx and esophagus.

(b) Tuberculosis of the oropharynx and esophagus.

(c) Stricture (benign) of the esophagus.

Syphilis of the esophagus.

3. Atony of the stomach not yielding to ordinary measures (extreme forms). Laryngeal tuberculosis.

5. Carcinoma of the cardia of the stomach.

6. Carcinoma of the larynx.

7. *Cardiospasm not yielding to ordinary treatment.*

8. Dysphagia from any cause not yielding to medical intervention.

9. As an avenue for inlets in [illegible] of the esophagus and stomach.

Historical Notes. Gastrostomy was one of the earliest operations employed by surgeons. Egeberg, a Norwegian military surgeon, advised its performance for cases of esophageal stricture, at the meeting of the Christiania Medical Society in

1837. However, he did not perform the operation. Sédillot in 1845, and [illegible], [illegible] performed it on dogs. Sédillot was the first to perform the operation on a human being in 1849 and later in 1853. Both patients died from peritonitis, [illegible] of abdominal operations in pre-antiseptic days. After that, there were many unsuccessful attempts to perform this operation on a human being. The first successful attempt, however, was made by Sydney Jones in 1875. This was the thirty-third attempt to perform it on a human being. A little later, in 1876, a French surgeon, Verneuil, modifying Sédillot's method, performed it also successfully.

The operation performed by Verneuil was such a way that his patient made it a means of livelihood, going from city to city demonstrating his fistula. This method was used by many surgeons until 1886, when von Hacker proposed his incision. At that time one great obstacle usually met the surgeon, namely the opening of the stomach was not watertight and the acid gastric contents, escaping from the lumen of the stomach, contaminated the peritoneal cavity producing fatal peritonitis, or irritated the skin producing painful eczema, so that many patients would prefer to starve from the original illness than to suffer from the excruciating pain produced constantly by the acid gastric contents irritating the surrounding skin.

To obviate that danger the early operators preferred to perform a "two-stage" operation. They sutured the anterior wall of the stomach to the anterior abdominal wall, leaving it for four or five days, until serous adhesions were formed between the exposed surfaces. Then the stomach was opened. But, as already stated, these methods were not satisfactory because the gastric contents escaped through the new stoma. Different means were devised to make the stomach watertight.

(1) Formation of a cone of a part of the stomach, the cone being retained in position by various devices. To this class belong: (a) Hahn's method and its modifications (Hagemann); (b) Kader-Senn-Frank method and its modifications (Ehrhardt, Jaboulay, Lucy).

(2) An attempt to make a sphincter of the abdominal wall: (a) Von Hacker; (b) Girard.

(3) An attempt to form a sphincter in the stomach wall itself: (a) Ullmann method.

(4) Operations in which a canal is made on the anterior gastric wall so that the canal is lined with serosa: (a) Witzel's method, etc.

(5) Operations in which a canal is made in the thickness of the anterior gastric wall and which is not lined with serosa: (a) Marwedel's method, (b) Schnitzler's method, (c) Fisher's method.

(6) Depage of Brussels, in 1901, and Janeway an American surgeon, in 1913, in order to obviate the unpleasantness of the serous surfaces encountered in the Witzel and other procedures, formed a tube from the anterior wall of the stomach. This tube being lined with mucous membrane, did not close and thus a distinct step in the right direction was taken.

(7) The next objective to overcome was to render the opening in the stomach leakproof. This was effectually accomplished by Professor Fontan of Toulouse, who in 1896 described his method of valve-formation before the French Congress of Surgery, stating: "The aim of my operation is to establish a gastric fistula so constructed that the escape of the gastric juice will be impossible. I have adopted this idea of valvular operation based on Fontan's experiments. In my operation not only the mucosa but all the coats of the stomach enter into the formation of the valve. I build the valve in one sitting by the aid of a simple operative procedure. There has never been detected any leakage of gastric juice or of gastric contents following this operation, and there has never been present any excoriations. There has never been present any ulcerations."

(8) Formation of a tube from a loop of jejunum implanted into the anterior wall of the stomach: Tavel's method.

Janeway described the method of Depage without knowing the latter's work in 1913. The Janeway-Depage method was modified by Petro Kitmann (see p. [illegible]) in 1930 and Quick and Martin in 1928.

others it is pale, creamy, and sometimes deep violet tinge. The swollen folds seem to crowd together hiding the spaces between the ridges—where there are no ridges the mucosa is mottled, dark, velvety. Purulent or mucopurulent secretions due to gastritis adhere tightly. Reclassification of varieties of gastritis based on gastroscopic observations will soon be necessary.

Fig. 1453. A. Superficial erosive exudative type of ulcer, with inflammatory area, on the margin of the esophagogastric junction of patient with hiatal hernia of the stomach. The erosions, the ulcers and the inflammatory zone are typical of hiatal hernia, and are probably due to contact of regurgitated acid gastric juice with the esophageal mucosa. B. Appearance same patient, three weeks later. The ulcers have healed but the structure remains. C. Appearance of same patient, [illegible] months later. A new crop of ulcers has developed and they are in two locations. (Jackson.)

Supradiaphragmatic Stomach. Definite diagnosis of hiatal hernia rather than esophageal disease is reached by gastroscopy; the open tube is best here since proper distance for good image with the lens system instrument is impossible; also, the folds over the distal end of the open tube allow minute inspection.

Chronic inflammation of the mucosa, often with erosions at the entrance—the part properly belonging in the group of the hiatal pouchsack of the diaphragm

Fig. 1454 Fig. 1455

Fig. 1454. Chronic ulceration, tubular portion of the supradiaphragmatic stomach as seen through the [illegible] gastroscope [illegible].

Fig. 1455. Gastroscopic view showing chronic gastritis in the herniated stomach [illegible]. The mucosa [illegible] swollen, and superficial erosions are visible on the three folds toward the left. The color was bright orange red. (Jackson.)

(Fig. 1453) is commonly present in the herniated part of the stomach. This form of gastritis, limited to the herniated stomach with symptoms suggestive of its ulceration has not been recognized hitherto (Figs. 1454, 1455).

New Growths in the Stomach. Gastroscopy diagnoses definitely benign or malignant growths, where roentgen examination is inadequate, or fails. Biopsy: Open tube biopsy is easily done—specimens are taken from the edge of the ulcer and in infiltrative lesions, the specimen is taken when the ulcerative stage reached.

SURGERY OF THE STOMACH

Stab and Gunshot Wounds

Wounds which penetrate the stomach call for immediate surgical attention to avoid peritonitis from leakage and bleeding. In the case of very small wounds in an empty stomach there may be very little leakage since the protruding mucous membrane may partly close the wound. Leakage is increased by vomiting which forces the stomach contents out of the wound. Examination should be made to ascertain injuries to the stomach wall, other viscera and bleeding from the larger blood vessels.

Step 1. If the patient is in shock, the operation should be begun under local anesthesia and if considerable exploration seems advisable, peritonitis suspected or the patient is very restless, administer general anesthesia. Gas-oxygen or ethylene anesthesia seems preferable since vomiting should be avoided.

Step 2. Sterilize the skin of the abdomen and lower chest with iodine. Make midline incision about 4 inches in length, extending it either upward or downward as conditions indicate. If there has been much bleeding, dark blood is observed behind the peritoneum.

Step 3. Lift up the peritoneum with two pairs of plain thumb forceps and incise it in line with the first incision made. Hold it away from the abdominal contents and observe closely whether or not there is an escape of gas, blood or stomach contents from the peritoneal cavity. Fluids which might be present are removed with suction apparatus or sponges.

Step 4. Raise the head of the table so that the intestines fall away from the epigastric area and the wound permitting more room for exploration. Separate the wounded portion of the stomach from the rest with laparotomy pads. Examine the front wall of the stomach where the lesion is likely to follow the wound. The stomach should be handled very gently at all times.

Step 5. Suture the wound, which does not need trimming as a rule, with two layers of sutures. The first layer should be done with No. [illegible] chromic catgut and the second with Pagenstecher linen (Lembert suture). In case of small wound a double row of purse-string sutures may suffice.

On some occasions, a large wound on the front wall of the stomach may be used to explore the back wall but generally it is wiser to close the injury on the front wall at once and make an incision in the gastrocolic omentum to examine the posterior wall. Carefully avoid injuring the branches of the colica media, duodenal and pancreatic while making this incision. After carefully examining and exploring the peritoneal cavity and its contents for all injury, close the incision with layer sutures supplemented by 3 or 4 through-and-through silkworm-gut sutures.

In cases where much of the stomach contents has escaped into the peritoneal cavity it may be necessary to irrigate; however, suction and sponging may obviate this. Small stab wounds in the anterior wall of the stomach may be closed without drainage. In the case of bullet wounds where a piece of clothing has also entered the stomach wall, and where the posterior wall also has been injured, if this is

accompanied by infection of the lesser sac, insert a rubber drain into the lesser sac and have it emerge through an aperture in the gastrocolic or gastrohepatic omentum and abdominal wound. Extensive drainage is not recommended. In cases of peritonitis or infection of the entire peritoneal cavity, however, introduce a rubber drain through a small stab incision in the region of the pelvis and place the patient in the Fowler position.

Comment. Some surgeons supplement the closure of the perforation by gastrostomy, claiming that by so doing thirst is eliminated, because the patient may be allowed as much water as he wishes after the operation; the water is permitted promptly to run off through the gastrostomy tube. I do not subscribe to such practice, it reminds me too much of Pavlov's sham fistula. The only advantage from a supplementary gastrostomy that I can see is that it puts the suture line at rest.

Operation for Perforated Gastric and Duodenal Ulcer

This operation was performed first by Mikulicz in 1880. In these cases the sooner the patient is operated on after perforation the better the prognosis.

Step 1. Make a midline incision or one to the right or left, as indicated. The incision should extend from the ensiform cartilage to the umbilicus. Adequate exposure is essential.

Step [illegible]. An efficient suction apparatus saves much time in clearing the abdomen of escaped gastric contents and peritoneal transudation depending upon the time the condition has lasted.

Step 3. Find the perforation. Deliver into the wound the portion of the stomach carrying the perforation. Surround the operative field with lap sponges of proper temperature. The perforation is often found surrounded by dense cartilaginous like induration through which sutures when introduced will promptly cut out. However, one suture embracing all coats of the stomach should be introduced temporarily to prevent further escape of gastric content. Use Levene duodenal drainage.

Excision of the Ulcer. It is unwise to excise the ulcer. It wastes precious time, besides causing bleeding.

Step 4. Infold the ulcer bearing area by superimposing as many interrupted sutures of catgut carried on a curved needle as necessary. The first suture should be placed at some distance from the perforation. The needle should take a big bite of healthy tissue. As already stated, when the suture is introduced through the indurated edematous tissue, it will cut out. The first interrupted suture acts as a tractor. Another interrupted suture is placed next to the first. It is tied. As many sutures as deemed necessary to secure complete closure and inversion of the opening are introduced (Fig. 1456).

Step 5. A tag of omentum or a free omental graft is made to reinforce the closed defect in the stomach. I have often used the falciform ligament to reinforce the suture line with gratifying results.

Step 6. Close the abdomen but do not omit drainage. Do not permit the drainage tube to come in contact with the sutured area. A suprapubic drain may be used to great advantage.

In perforated duodenal ulcer a drain should be used in the right flank (Morison's pouch).

Some (von Schnitzler) close the abdomen tight particularly in cases of early perforation.

Never omit to look for a second perforation. Sometimes perforations take place in positions difficult to reach. Some surgeons advocate resection of the ulcer bearing area. *Von Haberer, Koch and others advocate supplementary posterior gastrojejunostomy.* Basil Hughes and others condemn such supplementary procedures and put their faith, as does the author, in simple suture. A conservative surgeon would, I hope, certainly not think of doing a gastrojejunostomy in cases of perforation when there already is more or less obvious peritoneal contamination.

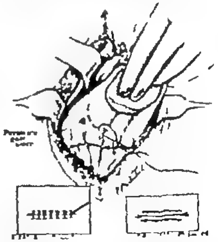


Fig. 1456. Operation for closure of perforated gastric ulcer. As many sutures as necessary to secure complete closure and tight inversion should be used.

Comment. Diagnosis must be prompt in these cases in order to save life. In doubtful cases it is better to do an exploratory operation and find no perforation than procrastinate and have the patient die as a result of delayed interference. X-ray is invaluable as a diagnostic means in obscure cases (pneumo-peritoneum). Lundy is partial to spinal anesthesia in these cases.

GASTROTOMY

This operation was first performed by Daniel Schwabe in 1635.

Indications. Removal of foreign bodies, benign tumors, obstructions of the cardia, and esophagus, removal of foreign bodies located in the lower end of

duodenum, it has been necessary to approach the fundus and use the diamond shaped area in order to get a proper channel for the passage of the tube.

Fig. 1265. Witzel gastrostomy seen from within.

Witzel Gastrostomy

The incision, delivery of the stomach and orientation are the same as in the previously described procedure. Introduce two inches of tube (a catheter about No. 13 French) through a stab wound in the stomach. Tie a purse string around it (Fig. 1264) to fix the catheter to the gastric wound with one or more catgut sutures. Lay the unattached portion of the tube along the surface of the stomach and bury it there either by a row of interrupted or a continuous Lembert suture passing through the seromuscular portion of the stomach wall. This results in a canal which is lined with serosa and extends along the surface of the stomach for about two or three inches. The outer opening of the canal is united with sutures to the parietal peritoneum of the anterior abdominal wall and the free portion of the tube is brought out of the abdominal wound (Figs. 1264 b, 1265). Close the abdominal wall, above and below the tube.

Fig. 1266. Gastrostomy. Ssabanejew-Frank operation. In the lower [illegible] the fundus of the stomach attached to the parietal peritoneum and posterior sheath of the rectus muscle. Through the [illegible] upper portion of the stomach [illegible] brought out [illegible] under the skin.

SSABANEJEW-FRANK ALBERT KOCHER GASTROSTOMY

Step 1. This operation consists of delivering a cone of stomach through a high upper left rectus incision and passing it through a subcutaneous tunnel.

Step 2. The apex of the cone is brought out through a short incision just above the left costal arch to the edges of which the apex cone is fastened after closing the primary incision below it (Fig. 1266).

Comment. This operation is often difficult to perform. A prerequisite to its successful performance is a sufficiently large stomach—a condition which does not often pertain, in carcinoma of the esophagus, for example.

Tavel Gastrostomy

In this operation a tube fashioned from a resected portion of the small intestine is inserted between the anterior abdominal wall and the stomach. While ingenious, this operation is difficult of performance and not recommended for general use.

Tube-Valvular Gastrostomy*

In this technic the valve allows the food to be introduced into the lumen of the stomach, and hermetically closes the stomach whenever the intragastric pressure is increased, thus preventing an escape of the food through the tube (Figs. 1267-1268).

Step 1. A quadrangular area is outlined on the anterior wall of the stomach three inches long and two inches wide (if, however, the stomach is not large

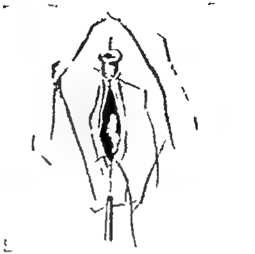


Fig. 1267. Fixation of the tube through which food is introduced into the stomach to the layers of the anterior abdominal wall in tube-valvular gastrostomy.

enough for this, it may be made two and one-half inches long and two inches wide). A forceps is placed at each angle of this quadrangular area (Fig. 1267).

Step 2. A seromuscular suture is made at the upper points of the incision. The distance between these is from one to one and one-third inches. An artery-forceps or sound is placed behind the threads connecting the incisions. The ends of the thread are also tied, and an artery forceps is placed on one end of the thread and with the other end of the thread on the needle the next step is performed.

Step 3. The two ridges thus formed are sutured together by a continuous seromuscular suture. Then, the upper half of the flap is doubled. The artery-forceps or probe, lying behind the bridge of folded stomach wall is now withdrawn.

* For the history, evolution and priority claims of this operation see "Historical Notes," p. 1465.

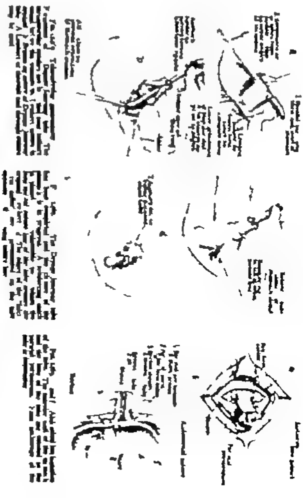
Step 4. Two seromuscular vertical incisions connecting with the lower angles of the quadrangular area are made, and also a transverse incision connecting these lower angles with each other. In order to prevent the contraction of the seromuscular layer while making the transverse incision each lower angle of the flap is caught by an Allis forceps before the transverse incision is made. If large blood vessels are seen on the mucous membrane they may be ligated before the mucosa is opened. Some prefer to ligate only the blood vessels which lie close to the stomach-wall and not those which are

Fig. 1268. Tube-valvular gastrostomy. Note tube made from anterior wall of stomach. Depage-Janeway.

close to the flap. However, they all may be ligated before the mucosa is incised.

Step 5. The exposed mucosa is cut and the flap reflected. A valve at the base of the flap is then clearly seen (Fig. 1269 b). Two buttonhole sutures are then made, one penetrating the upper two corners of the flap and the other passing through two points at the base of the flap. The ends of both are tied and clamped. The lower angle of the stomach-incision is grasped by Allis forceps. The ends of the two previously made sutures, which are the beginning and the end of the seromuscular suture which connected the ridges to each other, are now cut short, thus completing the formation of a Pousson valve.

Step 6. An artery-forceps (or as I prefer a short sound I devised having a small ring attached to the front, and at the top, and used for orientation) is inserted into the stomach through the tube thus formed. The opening into



(9) In 189[illegible] L. Fontan described [illegible] method of gastrostomy by forming [illegible] valve by [illegible] method of placing the mucous membrane [illegible] of the stomach, and in 189[illegible] Witzel [illegible] borrowed the idea of Fontan [illegible] valve-formation and combined it with Von Hacker's procedure.

(10) In 19[illegible] Jules Spivack borrowed the ideas of Janeway and Depage (tube formation) and Fontan-Fontan's (valve-formation) combining the two and calling the procedure Tubo-valvular gastrostomy.

Comment. Of all the methods of gastrostomy thus far described, the tubo-valvular combination worked out by [illegible]-Fontan-Janeway-Depage and Spivack is the best. The Depage-Janeway idea of tube formation was not only adopted by Spivack, but Pierre [illegible] of Montreal also took advantage of it and created [illegible] [illegible] tubed duodenostomy (see p. [illegible]). It must be stressed, however, that tubovalvular gastrostomy requires much technical skill to perform and unless resorted to by one of much experience, it is better to resort to the simpler methods of gastrostomy described in the text.

What Should an Ideal Gastrostomy Be?

[illegible] It should be lined with mucous membrane (Depage-Janeway operation).
[illegible] It must not permit leakage of gastric juice and liquids (Fontan operation).
3. No catheter should be needed between feedings.
4. Introduction of [illegible] tube for feeding, retrograde esophagoscopy, gastroscopy, retrograde bougienage and radium therapy should be easy.

Pitfalls Complicating Gastrostomy

Aspiration pneumonia may occur even under local anesthesia.
The nearer [illegible] gastrostomy is to the cardia, the better.
Avoid [illegible] about the tube.
Dropping out of the tube as in the Witzel operation.
Injury to the [illegible].
Lindner reports [illegible] case of [illegible] as [illegible] result of necrosis of the [illegible].
Infections are common. Saprophytic contamination (as [illegible]) adds greatly to infection.
Leakage of gastric juice through stitch holes in the suture line of the stomach or tube causing peritonitis (Anders and [illegible]). The placement of sutures is important. If placed too closely [illegible] necrosis results. If too far apart, dead spaces ensue.
Cutting out of sutures (Harvold).
Contracted stomachs offer greater difficulty for the performance of gastrostomy.
Prolapse of the mucous membrane of the stomach, particularly in the methods of Kader, [illegible], [illegible], [illegible], [illegible] and others.
Acute dilatation of the stomach.
Persistent vomiting.
In an ordinary gastrostomy, if the whole thickness of the stomach is not taken in, fixing the rubber tube, the latter [illegible].
Food may find its [illegible] way between the tube and the stomach causing infection.

[illegible]
[illegible]
[illegible]

Contamination of the [illegible] tract may cause serious damage to the skin. Prolapse of the stomach.

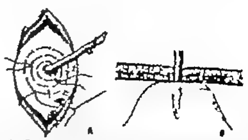


Fig. [illegible]. Gastrostomy. [illegible] operation. A. [illegible]

[illegible] reports a case in which [illegible] in the fistula [illegible] after [illegible] feeding, two years after the gastrostomy was performed.
The [illegible] of gastrostomies used nowadays will be described.

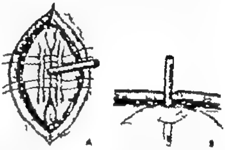


Fig. [illegible]. Gastrostomy. Kader operation. A. [illegible]

Kader's or Stamm's Operation

Step [illegible]. Open the abdomen and expose the stomach (Figs. [illegible]).
Step 2. Tease the junction of the body of the stomach and its pyloric portion well into the wound; [illegible] fold of the stomach from near the greater curvature. Make an incision about the thickness of a lead pencil, [illegible].

Step 3. Pick up the mucosa and open the stomach. Introduce [illegible] rubber catheter into the opening thus made. Clamp the end protruding from the stomach.
Step 4. Fix the tube to the gastric [illegible] with one or more interrupted chromic catgut sutures.
Step 5. Introduce [illegible] of Lembert sutures through the serosa and muscularis as shown in the illustration. Depress the stomach and the tube and the [illegible] resulting will form a valve projecting into the interior of the stomach.
Step 6. Superimpose [illegible] second row of sutures to accomplish the [illegible].
Step 7. Tube each Lembert suture the stomach to the anterior abdominal wall (parietal peritoneum).
Step 8. Close the abdominal wall above and below the tube.

Stallow Modification of Kader Operation

Thomas A. Shallow[illegible] describes [illegible] modification of the Kader operation based on thirty-[illegible] gastrostomies.

Step [illegible]. Make an incision four inches in length, under local anesthesia, at the upper margin of the left rectus muscle.
Step 2. Expose and identify the stomach.
Step 3. Place [illegible] stay stitch in the stomach and draw the stomach through the incision. Note the level of the cardiac entrance to the stomach and choose [illegible] to the left of the cardiac entrance.
Step 4. Divide the stomach wall down to the mucous membrane, through [illegible] very small incision.
Step 5. Pick up the mucous membrane with [illegible] small rat-tooth forceps through this opening. Ligate the blood-vessels before the mucous membrane is divided just large enough to admit [illegible] French soft rubber catheter.
Step 6. Fix the catheter with [illegible] catgut stitch so that three-eighths of an inch of the catheter is permitted to pass into the stomach cavity. The advantages of this very small opening are: prevention of hemorrhage, [illegible] of the [illegible] stitch layer, lessening the possibility of leakage of the stomach contents and prevention of regurgitation of liquid around the catheter.
Step 7. Place one or two purse-string stitches around the tube. From now on the object is to throw a diamond-shaped fold of the stomach wall around the tube, the upper and lower points of the diamond toward the greater and lesser curvature respectively, with the tube in the center of the diamond. Lembert stitches are used so that [illegible] small fold is thrown distal to the tube at the points of the diamond which are one to one and [illegible] half inches on each side of the tube. As the tube is approached [illegible] larger surface is included in the stitch so that at the level of the tube, the greater part of the stomach [illegible] included in the stitch and thrown around the tube.
Step 8. Attach the wall of the stomach to the parietal peritoneum. This step is necessary [illegible] great many patients after they have been discharged from the hospital permit the tube to remain out too long and it is then necessary to dilate the channel. Such dilatation [illegible] effected by passing [illegible] probe through

[illegible]

the opening and using uterine bougies of increased caliber to bring it up to the proper dimensions. If the stomach has not been fixed to the parietal peritoneum, this is much more difficult.

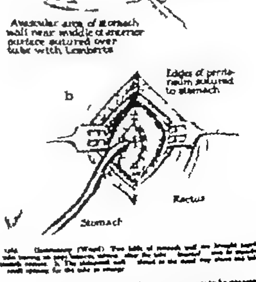


Fig. [illegible]. Gastrostomy (Witzel). Two folds of stomach wall are brought together over the tube [illegible]

Comment. While the procedure described may not seem to be necessary to the average surgeon who does the occasional gastrostomy, Shallow found that in lye [illegible], particularly in children where the stomach is found

duodenum, it has been necessary to approach the fundus and use the dome-shaped area in order to get a proper channel for the passage of the tube.

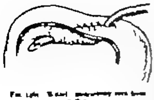


Fig. 1461. Witzel gastrostomy seen from [illegible].

Witzel's Gastrostomy

The incision, delivery of the stomach and orientation are the same as in the previously described procedure. Introduce two inches of tube (a catheter about No. [illegible] French) through a stab wound in the stomach. Tie a purse string around it (Fig. [illegible]). Fix the catheter to the gastric wound with one or more catgut sutures. Lay the unattached portion of the tube along the surface of the stomach and bury it there either by a row of interrupted or a continuous Lembert suture passing through an avascular portion of the stomach wall. This results in a canal which is lined with serosa and extends along the surface of the stomach for about two or three inches. The outer opening of the canal is united with sutures to the parietal peritoneum of the anterior abdominal wall and the free portion of the tube is brought out of the abdominal wound (Figs. [illegible]). Close the abdominal wall, above and below the tube.

Fig. 1462. Gastrostomy. Ssabanejew-Frank operation. In the lower picture are shown the borders of the stomach attached to the parietal peritoneum and posterior sheath of the rectus muscle. Through the stomach above another portion of the stomach is brought out after passing [illegible] under the skin.

SSABANEJEW-FRANK-ALBERT KOCHER GASTROSTOMY

Step 1. This operation consists of delivering a cone of stomach through a high upper left rectus incision and passing it through a subcutaneous tunnel.

Step 2. The apex of the cone is brought out through a short incision just above the left costal arch to the edges of which the apex cone is fastened after closing the primary incision below it. (Fig. [illegible].)

Comment. This operation is often difficult to perform. A prerequisite to its successful performance is a sufficiently large stomach—a condition which does not often pertain, in carcinoma of the esophagus, for example.

Tavel' Gastrostomy

In this operation a tube fashioned from a resected portion of the small intestine is [illegible] between the anterior abdominal wall and the stomach. While ingenious, this operation is difficult of performance and not recommended for general use.

Tube-Valvular Gastrostomy*

In this technic the valve allows the food to be introduced into the lumen of the stomach, and hermetically closes the stomach whenever the intragastric pressure is increased, thus preventing an escape of the food through the tube (Figs. 1463–1468).

Step 1. A quadrangular area is outlined on the anterior wall of the stomach three inches long and two inches wide (if however the stomach is not large

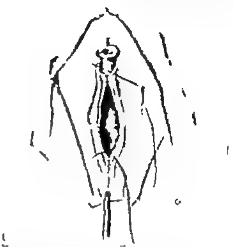


Fig. 1463. [illegible] of the tube through which food is introduced into the stomach to the layers of the anterior abdominal wall in tube-valvular gastrostomy.

enough for this, it may be made two and one-half inches long and two inches wide). A forceps is placed at each angle of this quadrangular area. (Fig. [illegible].)

Step 2. A seromuscular suture is made at the upper points of the incision. The distance between them is from one to one and one-third inches. An artery-forceps or sound is placed behind the threads connecting the incisions. The ends of the thread are also tied, and an artery-forceps is placed on one end of the thread and with the other end of the thread on the needle the next step is performed.

Step 3. The two ridges thus formed are sutured together by a continuous seromuscular suture. Thus, the upper half of the flap is doubled. The artery-forceps or probe, lying behind the bridge of folded stomach wall is now withdrawn.

* For the history, evolution and priority claims of this operation see "Historical Notes," [illegible].

Step 4. Two seromuscular vertical incisions connecting with the lower angles of the quadrangular area are made, and also a transverse incision connecting these lower angles with each other. In order to prevent the contraction of the seromuscular layer while making the transverse incision each lower angle of the flap is caught by an Allis forceps before the transverse incision is made. If large blood vessels are seen on the mucous membrane they may be ligated before the mucosa is opened. Some prefer to ligate only the blood vessels which lie close to the stomach wall and not those which are

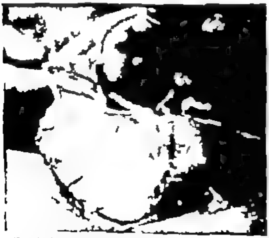
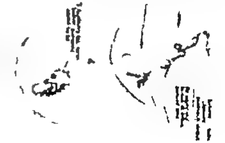


Fig. 1464. [illegible] gastrostomy. [illegible] tube made from anterior wall of stomach. [illegible]

close to the flap. However they all may be ligated before the mucosa is incised.

Step 5. The exposed mucosa is cut and the flap reflected. A valve at the base of the flap is then clearly seen (Fig. 1465 b). Two buttonhole sutures are then made: one penetrating the upper two corners of the flap and the other passing through two points at the base of the flap. The ends of both are tied and clamped. The lower angle of the stomach incision is grasped by Allis forceps. The ends of the two previously made sutures, which are the beginning and the end of the seromuscular suture which connected the ridges to each other are now cut short, thus completing the formation of a [illegible] [illegible] valve.

Step 6. An artery forceps (or as I prefer a short sound I devised having a small ring attached to the front, and at the top, and used for orientation) is inserted into the stomach through the tube thus formed. The opening left



GASTROPLICATION

This consists of folding, plicating or pleating either aspect of the stomach—anterior or posterior. It finds its indication, on occasion, in marked stomach

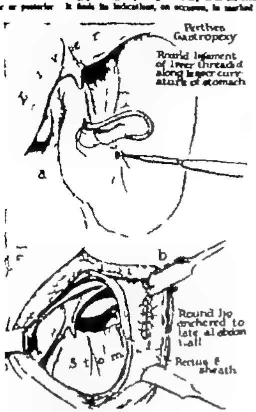


FIG. 1481. Perthes gastropexy. Note course of round ligament of the liver along course of lesser curvature of stomach through the abdominal wall to the point of anchorage to the costal margin and fascia of the transverse abdominis muscle.

dilatations of the stomach not due to obstruction at the pylorus. Sometimes it is resorted to in cases of gastroptosis. It was Friedrich Bircher of Aarau, Switzerland. He performed the operation first in 1890 and described it the following year. His method follows:

Step 1. Open the abdomen by a straight incision beginning at the ensiform cartilage and extending to opposite the umbilicus.

Step 2. Deliver the stomach from the abdomen. A seromuscular suture connects two points, close to the pyloric end of the stomach and a similar suture those of the cardiac end. The ends of the respective sutures are tied.

Step 3. Place a probe behind the two knotted points, thus creating a furrow with two ridges on the surface of the stomach.

Step 4. Suture the crests of the parallel ridges thus constructed to each other by means of a continuous seromuscular suture. The stomach wall is thus doubled on itself.

Comment. The drawback of this method is that it reduces the size of the anterior stomach wall only, leaving the posterior wall unchanged. Again the plicating of the anterior wall causes a large portion of the stomach wall to protrude into its interior giving rise to obstruction. To obviate these drawbacks R. F. Weir devised the following modification of the original Bircher method.

Weir's Modification of Bircher's Method

Step 1. Make a furrow an inch deep on the anterior wall of the stomach by means of a glass rod or probe. The extent of this furrow depends upon the length of the stomach in terms of its transverse diameter. Uninterrupted seromuscular sutures are then taken transforming the furrow into a canal.

Step 2. Remove the probe or glass rod and create a similar furrow or canal about one inch below the first one, in the same manner.

Step 3. Repeat this procedure until the distance between the greater and lesser curvature approximates about 1½ inches.

Comment. It is obvious that Weir's modification eliminates the disadvantages of the Bircher procedure enumerated above. Moynihan supplements gastroplication with gastrojejunostomy.

Moynihan's Method

Step 1. Insert a series of interrupted seromuscular sutures running in the direction from the lesser to the greater curvature in such a manner that each suture takes three or four bites. The distance between these bites is about one inch. Knot the ends and cut the suture short.

Step 2. Perform a posterior gastrojejunostomy.

VOLVULUS OF THE STOMACH

This condition may be met occasionally. I reported such a case at the meeting of the American Medical Association in San Francisco, in 1923, the salient features of which follow:

Mrs. A. F., a widow aged 77, had pneumonia during 1895 and again seven years ago, otherwise she was never ill and enjoyed good health, except for chronic constipation. There was no previous history of gastric ulcer or dyspepsia.

Two days previous to admission to the hospital (Dec. 19, 1922), the patient had been, after

partaken of some indigestible food. The bowel action, for three days before that time, had been constipated. Toward evening she experienced rather sharp pains in the upper part of the abdomen, radiating from the right to the left hypochondrium. At the onset of these pains there was constant ejection of the stomach contents, which gradually subsided, to be superseded by nausea. From that time on the abdomen (below the umbilicus) became very much distended and, despite attempts at catharsis and enemas, as well as intramuscular administrations of pituitary extract and physostigmine salicylate, no bowel action could be

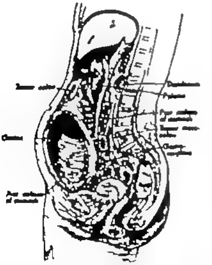


FIG. 1482. Degree of torsion of the stomach, 180 degrees. ... the relative position of the pylorus and cardia may be noted.

obtained. From the day of admission to the hospital, retching yielded a small quantity of mucus, tinged with blood.

Physical Examination. The general appearance of the patient was that of one suffering severe agony. The temperature was subnormal (96.8° F.), the pulse was of good quality, 88 and arrhythmic. The head, neck and thorax were normal. There were no cardiac murmurs. The systolic blood pressure was 135 diastolic, 80, pulse pressure, 55. Urinalysis and blood examinations were essentially negative. The abdomen showed marked distention, commencing about two fingerbreadths above the umbilicus and extending down to the symphysis pubis and spreading laterally to the flanks. The recti abdominal muscles were rigid; no peristaltic waves were visible. Despite the emaciated condition of the patient, and consequent thinness of the abdominal wall, circulatory phenomena could not be elicited. There was uniform, dull, tympanitic resonance all over the distended area. Attempts to pass a stomach tube were unsuccessful.

Acute intestinal obstruction and stricture at the cardiac end of the stomach were diagnosed.

Operation and Result. Under spinal anesthesia (tropacocaine) a median celiotomy was made. A large mass resembling a distended ovarian cyst appeared in the peritoneal opening. The thought occurring at that moment was the possibility of an incarcerated ovarian cyst with twisted pedicle and compression of certain segments of the intestinal tract, giving rise to intestinal obstruction.

Exploration by passing the left hand over the mass into the pelvis, lifting it up and outward in an attempt by means of an ovarian trocar, revealed the true nature of the condition. It was dealing with the stomach. Its weight and enormous size made it difficult to deliver it into the wound. After packing the surrounding area with laparotomy sponges, wrung out of warm salt solution, and evacuating the stomach contents (found to consist of undigested food particles and an enormous quantity of gastric fluid of turbid appearance and putrid odor), the tumor was reduced in size, permitting its delivery into the wound, where it was found to be completely twisted on its horizontal axis about 180 degrees, the pylorus being dragged to the left side while the cardiac end was completely rotated (Fig. 1482). The transverse colon was vertical and along the lesser curvature. The spleen was displaced forward and upward.

Detorsion was effected, after which the stomach was found to be extremely ptosed. I suspended it to the anterior abdominal wall by the Rovsing method of gastropexy. The patient experienced no pains during the operation, uncomplicated. She was returned to bed in excellent condition. No shock.

No fluids were permitted by mouth for the first twenty-four hours. Dextrose and salt solution were administered by rectum. Gastric lavage was done morning and night, for seventy-two hours. Gradually liquids were allowed by mouth followed by semisolid and solid foods, respectively. Complete recovery ensued.

Treatment. The treatment of volvulus of the stomach can only be surgical. A correct appreciation of the condition, either before operation or after opening the abdomen, is essential, as delay in proper treatment or failure to recognize the findings may be fatal. When recognized early evacuation of the stomach, detorsion and fixation are all that is necessary to afford complete relief.

The first operative procedures include: (a) Incision; (b) examination of the existing conditions and making a diagnosis if not diagnosed already; (c) evacuation of the stomach contents, and (d) the detorsion proper. The volvulus can be considered as reduced only when the ramifications of the coronary arteries of the stomach are placed in their proper relations.

The complementary operations are either a gastropexy (anterior parietal) or Coffey's operation of gastropexy which fixes the organ in a good place; or if there is any concomitant stenosis, a gastro-enterostomy, jejunostomy or fistulization of the stomach. The actual condition of the patient must determine the choice of operation.

Kuel thinks detorsion and gastro-enterostomy preferable to gastropexy.

OPERATIONS FOR HOUR GLASS STOMACH

In this condition the stomach is divided into two sections by a constriction which may be situated at any point between the pylorus and cardiac end of the stomach. The following operations come under consideration in an endeavor to remedy the condition:

Gastro-enterostomy—anterior or posterior.

Double gastro-enterostomy—Weir and Foote's operation which consists of joining the jejunum with each sac in the stomach.

3. [illegible] operation. Double gastro-jejunostomy [illegible]
   Gastrogastrostomy
4. Partial gastrectomy
5. [illegible] operation. [illegible] of the constriction

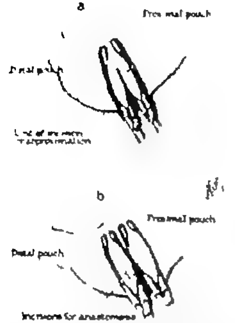


Fig. [illegible]. Gastrogastrostomy for hour-glass stomach. [illegible]

[illegible] operation is [illegible] and [illegible] to pyloroplasty as [illegible] operation to pyloroplasty. [illegible] operation as follows. Beginning at the lowest point of the constriction, running suture was applied through the serous and muscular coats, bringing the vertical edges of both compartments of the stomach into close approximation along their posterior margins. An inverted V-shaped incision was now made

through the entire thickness of the stomach wall, about one-quarter of an inch to either side of the Lembert suture. The posterior [illegible] edges were now brought together with another running suture from [illegible] the same procedure

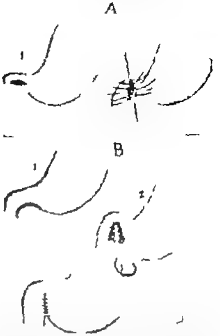


Fig. [illegible]. [illegible] operation for pyloric obstruction (pyloroplasty). [illegible]

being then applied to the anterior edges from without. The final act of the operation consisted in reinforcing the anterior suture with a running Lembert stitch, and placing a few extra sutures at the lowest point of the stomach through the serous and muscular coats, where tension would naturally be greatest.

Gastrogastrostomy or Gastro-anastomosis (Fig. [illegible])

[illegible] vertical incision [illegible] on the dependent portion on each side of the central constriction and suture these so as to form [illegible]

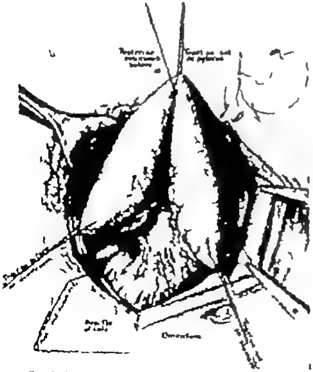


Fig. [illegible]. [illegible] Courtesy of Dr. John M. T. Finney and [illegible] Co.

beneath the isthmus. A clamp is applied on each side of the isthmus and the clamps surrounded by hot lap sponges. A seromuscular suture is applied below the isthmus down to the greater curvature of the stomach. Put the needle aside.

[illegible] both pouches in the grasp of the clamps. Introduce [illegible] second inner suture and complete the operation, precisely as in classical gastrojejunostomy (Fig. [illegible], p. [illegible])

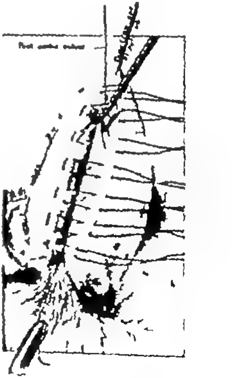


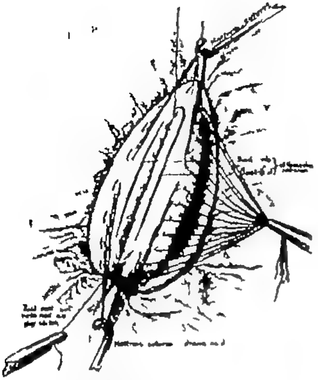
Fig. [illegible]. Posterior [illegible] Courtesy of Dr. John M. T. Finney and [illegible] Co.

PYLOROPLASTY (PYLOROTOMY)

[illegible] Operation

This operation was first performed by [illegible] of Dr. Friedrich [illegible] clinic described the

Mikulicz described the operation independently not being aware of Heineke's work—hence the operation is known as the Heineke-Mikulicz operation (Fig. [illegible])



[illegible] Anterior [illegible] suture [illegible]. Suture completed through the anterior gastric and duodenal walls. (Courtesy of Dr. John M. T. Finney and W. B. Saunders Co.)

Step [illegible] Make [illegible] right rectus incision.
Step 2. Deliver the pylorus.
Step 3. Place lap-sponges and engage the affected segment between rubber-covered clamps on either side. Make a horizontal incision (Fig. [illegible]) [illegible] cm to [illegible] cm long across the anterior wall of the pylorus, dividing it. If the

incision is made shorter the stenosis is apt to return. Introduce [illegible] sharp hook at the midpoint of the upper and lower lips of the incision. Traction on these will convert the horizontal wound into [illegible] vertical one.
Step 4. Suture the wound vertically with two rows of sutures.
(a) Inner, through-and-through or Connell suture (catgut)
(b) Outer Lembert suture [illegible] linen or silk (Fig. [illegible])

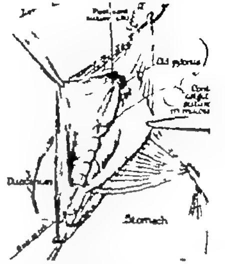


Fig. [illegible] Finney [illegible] Introducing the [illegible] row of sutures.

Comment. This operation is simple of execution but [illegible] in the presence of dense adhesions. It is mentioned here for its historical interest. Most surgeons have abandoned it and resort to the Mikulicz pyloroplasty described below or, still better, to Finney's pyloroplasty operation.

Mikulicz Pyloroplasty

Step [illegible] Make an incision along the lower border of the [illegible] pylorus extending into the duodenum and stomach on either side of the pyloric ring.
Step 2. Unite with [illegible] continuous Lembert suture the seromuscular coats of the posterior margins of the wound consisting of stomach and duodenum.
Step 3. With [illegible] through-and-through catgut suture, invert the posterior wall of the structures sutured and continue it in the same manner anteriorly.
Step 4. Continue the seromuscular suture over the last (inner) suture line anteriorly (Fig. [illegible])

Finney Pyloroplasty

Step [illegible] Mobilize the pylorus and duodenum. The latter must be freely movable (detach [illegible] from its moorings) so that it can be brought into apposition with the pylorus without tension. Properly placed [illegible] sutures aid in the proper apposition.
Step [illegible] Apply rubber covered clamps to the duodenum and stomach in [illegible] vertical direction. The tips of the clamps grasp those portions of the stomach

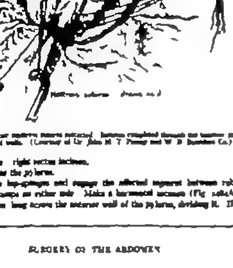


Fig. [illegible] [illegible] [illegible] placed [illegible] [illegible] placed [illegible] (Courtesy of Dr. John M. [illegible] Finney and W. B. Saunders Co.)

and duodenum in which the anastomosis is to be made but leave the upper portion of the duodenum to which the first traction suture is applied, free. Bring the clamps together. Protect the peritoneum thoroughly with gauze packs. The further technic resembles that described under gastroenterostomy (p. [illegible]) except that into the respective viscus an inverted U-shaped incision is made (Fig. [illegible])
Step 3. Unite the opposing surfaces of duodenum and stomach with [illegible] continuous suture (linen or silk), thus creating the outer (posterior) suture layer. Leave the lower end of the suture long with the needle attached to it (Fig. [illegible])

Step 4. Make an inverted U-shaped incision on each side of the outer line constructed by the horizontal part of the inverted U. This will give rise to an opening in each viscus of about [illegible] inches (Fig. [illegible])

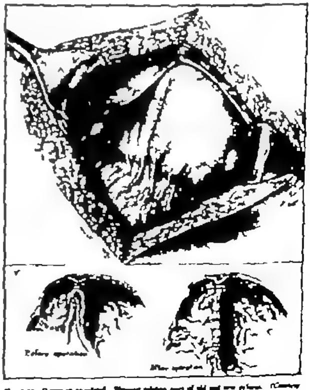


Fig. [illegible] Operation completed. [illegible] relative size of old and new pylorus. (Courtesy of Dr. John M. T. Finney and W. B. Saunders Co.)

Step [illegible] Introduce, beginning from above [illegible] through-and-through stitch of fine chromic catgut bringing the mucoso-muscular layers of the duodenum and stomach together. Continue the suture to the lowest point of the opening.

then return, embracing ½ of the coats of the anterior layers to the upper angle of the incision. Tie. (Figs. 458, 459, 460.)

Step 6. Continue the first sero-muscular suture by picking up the first needle left long and bury from right the second suture line.

Close the abdomen in layers.

Comment. One of the strongest points in favor of this operation is that it gives an opportunity to explore digitally and to excise the ulcerated area through the above-described incision.

(See Joyce's operation for Resection of the Proximal Duodenum and Neuro operation on page 403.)

Congenital Pyloric Stenosis

Rammstedt-Fredet Operation (1912)

Rationale. The Rammstedt procedure is based upon the fact that in congenital pyloric stenosis the hypertrophied circular muscle compresses and obliterates an otherwise normal mucosa and lumen (Fig. 149.)

Fig. 149. Congenital pyloric stenosis. Note constriction about the pylorus and the dilatation of the stomach.

Anesthesia. Local, by preference. A "sugar teat" is of great aid. Ether adds considerably to the risk of the operation.

Step 1. Make a longitudinal incision the full length of the tumor mass, which is often as firm as cartilage (Fig. 150.). The pyloric tumor is delivered promptly with the thumb and index finger. During this maneuver the stomach itself is not delivered except an inch or so of the pyloric end.

Step 2. Incise this tumor down to but not into the mucosa. Careful spreading will reveal a plane of cleavage between the hypertrophied muscle and the mucosa.

Step 3. Spread the incision with a pair of small but fine pointed hemostats so as to cause retraction and separation of the muscle from the mucous membrane (Fig. 150 b). Such will now be seen to herniate into the incision. Bleeding is usually negligible. Careless sponging may, however, precipitate bleeding.

Step 4. Replace the pylorus into the abdomen.

Step 5. Close the wound with through and through silk or silkworm-gut sutures.

Comment. Many surgeons resort to gastro-enterostomy in these conditions. I believe this to be too radical a procedure in these usually starved and weak infants. The simple operation, as described, is safer and usually

just as effective. The secret of success depends upon meticulous gentleness. Proper preoperative preparation and postoperative care are essential. Use as short an incision as is consistent with good exposure and

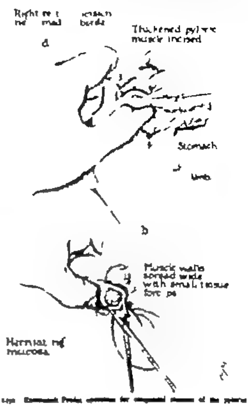


Fig. 150. Rammstedt-Fredet operation for congenital stenosis of the pylorus.

careful work. In accidental opening into the duodenum, painstaking closure with fine, interrupted catgut sutures must be done. A large rent in the mucosa, not easily repaired, calls for gastrojejunostomy with pyloric exclusion. Complicated time-consuming myoplasties are neither indicated, nor offer better results.

RESECTIONS OF THE STOMACH

Pean-Rydygier Billroth I Operation

In the original Pean-Billroth I operation, the pyloric portion was excised and the duodenal stump was joined to the greater curvature of the stomach. The chief objection to this procedure was that there existed a peculiar liability to leakage at the triangular point where the line of sutures in the upper portion of the end of the stomach came in contact with the duodenum and the suture line spread. At this point leakage frequently occurred. Another objection found to the original Pean-Billroth I was, that suturing the thin-walled duodenum to the thick wall of the stomach necessitated an invagination that would tend to occlude the lumen, thus causing obstruction. Today the Billroth I is performed as follows. Follow closely description in conjunction with Figs. 493-494.

Step 1. Open the abdomen.

Step 2. Outline the segment of affected stomach to be removed.

Step 3. Divide the gastrohepatic and gastrocolic omenta as in the Billroth II procedure (vide infra).

Step 4. Apply clamps to the mobilized duodenum and divide. Put two clamps on the stomach proximal to the lesion and divide. The clamp shown on the stomach side enables the reduction of the gastric orifice along the lesser curvature as advised by W. J. Mayo. (This is a Payr stomach clamp the tip of which has been [illegible].) Narrowing may be accomplished by dissecting out the necessary portions of the lesser curvature and inserting sutures as shown in Fig. 493 ( ).

Step 5. The first and second row of sutures as shown here are placed along the resected lesser curvature up to the point of proposed duodenogastric anastomosis (Fig. 493 [ ]). A rubber covered clamp is placed on the stomach behind the crushing forceps before the latter is removed.

Step 6. An anastomosis is now performed between the duodenum and stomach (Fig. 493 [ ]) on the same principles as outlined in performing gastrojejunostomy (see pages 338, 343 and Figs. 31, 314).

Step 7. The essential defect is obliterated by suturing the lesser omentum over the gastric reduction suture.

After the Pean-Billroth I operation there is a tendency for the stomach to drop to the left of the spine, its weight exerting an injurious strain on the suture line uniting the duodenum to the gastric stump. This may be obviated by the method of W. J. Mayo. He chooses a point in the anterior wall of the stomach sufficiently far to the left, the stomach is drawn to the right and attached to the suspensory ligament of the liver by several catgut sutures in such manner as to bring the suture line permanently to the right of the spine.

An important point to be constantly kept in mind in doing a Pean-Billroth I, is that the stump of the stomach must be capable of easy approximation to the duodenum.

In the Finney-Haberer modification of the Billroth I operation the duodenal opening is closed in the usual manner and the stump of the stomach is implanted in the side of the duodenum. Haberer's modification is an end-to-end anastomosis (Fig. 494 [ ] and [3]).

Horsley's Modification of Billroth I Operation[1]

Horsley suggested some modifications of the Billroth I technic which are illustrated in Figs. 1495-1496-1497-1498 and 499. Certain difficulties are circumvented with this procedure. A wide resection, at least 1 cm. beyond the obvious involvement of the stomach should be done. Free mobilization is essential.

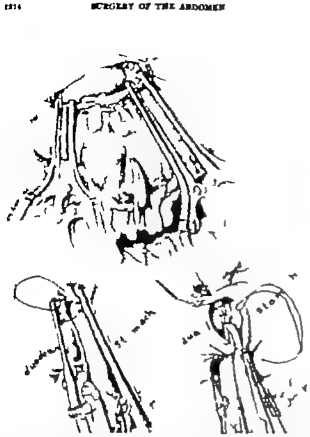
Fig. 1498   Fig. 1499

Fig. 1498. Resection of the stomach. Billroth I operation. After the removal of the affected portion, the stomach between Payr clamps the mobilized duodenum is placed on the side of the stomach as shown; the duodenum and [illegible] attached by a [illegible] suture [illegible] the duodenum to the stomach. Note [illegible] of respective lumens. The upper portion of the lumen of the stomach is closed. The suture [illegible] the [illegible] of the stomach and duodenum is left long. The [illegible] of the stomach and duodenum is [illegible] with [illegible] sutures. The operation is completed by picking up the suture left long and [illegible] the anterior wall of the duodenum with that of the stomach. The final steps consist in [illegible] and proper approximation of the [illegible].

Fig. 1499. Modifications of the Billroth I resection of the stomach. Original method of Billroth I operation. Haberer modification of Billroth I operation by an end-to-end anastomosis. "Haberer" modification of the Billroth I operation by an end-to-side anastomosis. Kocher modification of the Billroth I operation.

Some of the ligatures on the blood vessels are left long, to prevent their slipping. The clamped stomach and duodenum are detached with the electrocautery. The region, in which this operation is performed is peculiarly subject to [illegible] and traction and additional suturing is, therefore necessary. The advantages of this procedure are that the pathological lesion is excised

[1] Surg., Gynec. & Obst., Feb. [illegible]



[illegible] A. The [illegible] and [illegible] vessels have been divided and tied as [illegible]. [illegible] clamps are placed on the body of the stomach and on the duodenum just beyond the pylorus.
B. The segment of stomach has been removed, preferably with the electric cautery. The posterior margin of the stump of the stomach [illegible] sutured to the posterior margin of the stump of the duodenum with interrupted [illegible] sutures of [illegible] or chromic catgut.
C. The anterior row of sutures [illegible] being applied, uniting the anterior margins of the stump of the stomach to the anterior margin of the stump of the duodenum. The [illegible] shows where the suture will be made [illegible] the duodenum [illegible]. (Courtesy of Dr. J. [illegible] Horsley.)

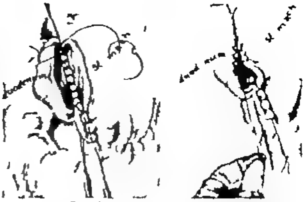


FIG. 1448. FIG. 1449.

FIG. 1448. The duodenum has been [illegible] and the posterior row of sutures completed. The anterior row of sutures [illegible] begun and the [illegible] and [illegible] being tied to the short end of the posterior row of sutures.

FIG. 1449. The anterior row of sutures [illegible] at each [illegible] so as to [illegible] the margins of the duodenum and stomach. The suture is [illegible] from the duodenal [illegible] while slight pressure with the thumb or finger [illegible] on the wound just beyond the [illegible]. (Courtesy Dr. J. Shelton Horsley.)

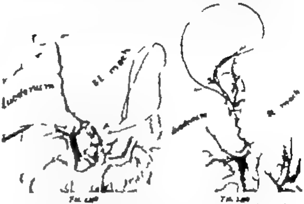


FIG. 1450. FIG. 1451.

FIG. 1450. A [illegible] of fine [illegible] or [illegible] catgut [illegible] placed at the lower portion of the [illegible] of the [illegible], [illegible] the [illegible].

FIG. 1451. The [illegible] [illegible] with [illegible] or [illegible] right-angle [illegible] with an [illegible]. An [illegible] placed near the lower border of the stomach and the duodenum [illegible]. The [illegible] are shown in the diagrams. (Courtesy Dr. J. Shelton Horsley.)

function of the stomach is restored as nearly as possible to normal. The physiologically active lesser curvature of the stomach is aligned with the upper border of the duodenum which is its normal relationship. The physiologically inactive greater curvature is easily folded in. The great objection to the original Billroth I operation is the so-called "deadly triangle" which occurred when the stump of the duodenum was aligned to the greater curvature where [illegible] more mobile. By bringing over peritoneal covered fat, this region is made secure. Flaring open the duodenum after it has been freed by sutures does not displace its relationship to the upper border of the stomach and at the same time gives [illegible] wide opening which prevents contraction and will distribute [illegible] sufficient [illegible] for food even if recurrence of the cancer makes some obstruction in this region.

The field of operation [illegible] limited to the vicinity of the lesion and does not involve the possibilities of spreading bacterial infection or cancer cells to the other organs or to tissues below the transverse mesocolon, which might be possible in the types of Billroth II.

Comment. There are many cases in which the stump of the stomach cannot satisfactorily be united with the duodenum. Under such conditions one must resort to [illegible] Billroth II operation or some of its modifications. Dr. [illegible] continued to use the Billroth I only occasionally, even if the duodenum has lent itself to free mobilization.

von Haberer's Technic for Radical Resection of the Stomach Following Previous Gastroenterostomy

is described by R. Russell Best as follows:

In von Haberer's clinic the Billroth No. I [illegible] the operation of choice because it is the most physiologic-anatomic operation. The stomach [illegible] made to empty into the duodenum directly by means of an end-to-end anastomosis. The direction of flow of intestinal contents [illegible] maintained and mechanical complications are less to be feared.

Step [illegible]. Make an median incision in the abdomen. Meticulously separate adhesions between the liver, stomach and duodenum. Examine the walls of the stomach and duodenum.

Step 2. If necessary, open the gastrohepatic and gastrocolic omenta. Lift up the transverse colon and free any existing adhesions. Examine the loop of anastomosis. Detach adhesions around the gastroenterostomy by blunt and sharp dissection.

Step 3. Insert [illegible] long spoon forceps transversely to act as [illegible] guide. Separate the transverse mesocolon from the margin of the anastomosis by working from above and below.

Step 4. An exceedingly important step [illegible] to free the duodenum. Ligate the right gastric and right gastro-epiploic arteries first. Ligate meticulously the gastrohepatic and gastrocolic omenta. Carry this up on the lesser curvature of the stomach to the point where the left gastric artery enters the stomach wall.

Annals of Surgery, August, [illegible]

Step 5. Take down the gastroenterostomy. Resection of the jejunum is usually unnecessary. Place [illegible] curved Doyen clamp upon or just below the line of anastomosis. Place intestinal clamps upon the jejunum just below and behind the anastomosis. Divide the anastomosis below the Doyen clamp [illegible] an electric cautery. Suture the opening in the jejunum transversely. Place guide sutures at both ends and apply continuous locked catgut sutures to the mucosa. Leave the ends of the sutures long and replace the former guide sutures. Insert interrupted linen Lembert sutures to complete the closure.

Comment. If [illegible] great deal of the jejunal wall is to be removed, do resection and follow it with an end-to-end anastomosis. I[illegible] this procedure, ligate the mesentery of the jejunum just opposite the anastomosis. Place crushing clamps on the jejunum on either side of the anastomosis [illegible] place intestinal clamps about [illegible] inch from the crushing clamps. Perform an end-to-end anastomosis by first inserting [illegible] layer of interrupted linen (Lembert) sutures on the posterior wall and then [illegible] continuous locked catgut suture to the mucosa. Finally insert [illegible] layer of interrupted linen sutures on the anterior wall. Close the wound in the mesentery with interrupted catgut sutures.

The duodenum may be further mobilized by doubly ligating small strands of tissue and cutting. Place [illegible] Doyen clamp on the pyloric portion of the stomach. Grasp the pylorus between the thumb and fingers of the left hand and place guide sutures on the lower and upper margins of the duodenum at the desired level. Hold the pylorus and both guide sutures in slight tension [illegible] cut through the anterior wall of the duodenum below the ulcers with the electric cautery. Inspect the mucous membrane of the posterior wall. Insert [illegible] small sponge into the duodenum to prevent regurgitation. Cut through the posterior wall below the ulcers. If the posterior wall is in good condition and the peritoneum is not too scarce, do [illegible] Billroth N[illegible] I.

Place [illegible] clamp on the stomach at the desired level of resection. Bring it into approximation with the duodenum to decide whether or not an end-to-end anastomosis is possible. Place [illegible] Lembert suture through the lower angles of the stomach and duodenum and another through the upper angles of the stomach and duodenum. Between these two sutures insert another stitch through the stomach and duodenum—clamp the sutures; do not tie them. Remove the two guide sutures on the duodenum. Insert Lembert sutures between these three, then tie the two angle and middle sutures; tie the remaining sutures and cut all but one on each end which are used for guide sutures. von Haberer's hemostatic sutures are inserted as follows: Cut through the serous and muscular layers of the stomach about one-half inch above the row of the interrupted Lembert sutures. Place [illegible] row of interrupted hemostatic catgut sutures along the lower cut margin. These sutures besides being hemostatic narrow the opening of the stomach. Displace the stump of the stomach to the right and cut through the serosa and muscularis about one inch above the clamp; place [illegible] similar row of sutures on the surface of the stomach. Leave these two groups of hemostatic sutures long and clamp them so that one group

is to the right and the other group to the left; they serve as retracting and guiding sutures. Place [illegible] clamp on the stomach just above the row of [illegible]

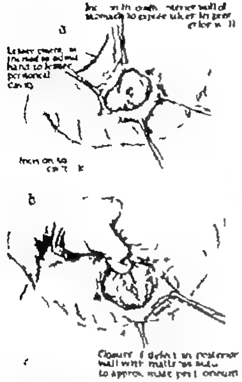


Fig. [illegible] Transgastric resection of ulcer from posterior wall. [illegible]

[illegible] and suspends the stomach with the [illegible] artery. Cut the sutures to the right [illegible] the suture of the posterior wall of the stomach and duodenum with [illegible] locked catgut suture penetrating all lay-

ers. Cut the sutures to the left. Continue the suturing on the anterior wall for [illegible] short distance) remove the great clamp from the duodenum and [illegible] the stomach. Place interrupted linen Lembert sutures on the anterior wall at the [illegible] and in the middle and tie them. Remove the clamp from the stomach and complete the row of interrupted linen Lembert sutures picking up more tissue than before.

If this procedure cannot be carried out do [illegible] Billroth No. II with an enterostomy. Compared with the simple posterior Billroth No. II there is in this method less likelihood of stasis and back pressure [illegible] in the stump of the duodenum, and later if another operation is necessary it is easier to take down an anterior Billroth No. II, than [illegible] posterior Billroth No. [illegible]

TRANSGASTRIC RESECTION OF ULCER ON THE POSTERIOR WALL OF THE STOMACH

Approach the affected area either through an avascular space in the transverse mesocolon or, if difficult to perform, through the anterior wall of the stomach.

Excise the ulcer. Close [illegible] from [illegible] the stomach by [illegible] through-and-through suture of chromic catgut. Reinforce it if possible with serous sutures from without. Fig. [illegible] depict and describe the steps of the operation.

EXCISION OF ULCER FROM THE LESSER CURVATURE (WEDGE RESECTION)

This operation may be extremely difficult because the ulcer may be very adherent to contiguous structures (pancreas, liver, etc.).

Open the abdomen in the usual manner. Ascertain the extent of the ulcer and the extent of complicating adhesions. Divide the gastrohepatic omentum above the ulcer. Ligate the vessels on either side of the ulcer bearing area. Divide the vessels. Enter the lesser peritoneal cavity with the exploring hand behind the stomach. Explore thoroughly.

Isolate the affected area with packs; apply clamps on either side of the area to be resected. Resect [illegible] triangular portion of the stomach bearing the ulcer. Do not carry the points of the clamps [illegible] the area to be resected too far down toward the greater curvature. As much healthy tissue of the stomach as is consistent with safety should be conserved. [illegible] the clamps together.

Suturing [illegible] Pagenstecher linen or chromic catgut is [illegible] in the following manner. Make [illegible] loop in the mucous membrane as shown in Fig. [illegible] A and B. This suture is begun [illegible] the greater curvature and continued upward toward the lesser curvature. The suture then [illegible] along the anterior surface of the stomach toward the greater curvature. Tie. Remove the clamps. Beginning at the posterior surface reinforce the suture line by [illegible] continuous Pagenstecher suture and bring [illegible] along the front all along the anterior surface. Tie. Close the opening in the gastrohepatic omentum. Close the abdomen (Fig. [illegible] C).

Comment: On excision alone, Balfour wrote:

"Excision alone for gastric ulcer is an operation which has been abandoned because other methods of surgical treatment have proved to be more effective. Experience has shown that recurrence of ulceration or of symptoms sufficient to classify the results as poor, occur in about [illegible] per cent of

cases. In many of these cases, secondary operation is required to bring about complete cure. Therefore, surgeons have adopted the practice of combining either gastro-enterostomy or pyloroplasty with removal of the lesion. The fact that excision alone has proved so inadequate in the permanent result is the most conclusive proof that in any operation for peptic ulcer some permanent [illegible] must be made in gastric function. This proof

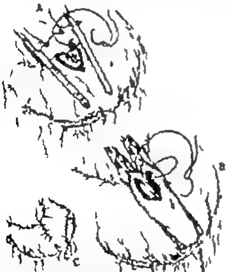


Fig. [illegible] Wedge resection for ulcer of the stomach. [illegible] The gastrohepatic omentum [illegible] and the blood vessels are ligated. The ulcer-bearing area resected. [illegible] The operation completed.

is particularly apparent in gastric ulcer since the usual situation of the ulcer is at some distance from the pylorus, where it can be removed without producing marked deformity of the stomach. The fact that removal alone of [illegible] gastric ulcer gives such unsatisfactory results is further evidence that disturbance in gastric function is an important factor in the production of ulcer. We believe, however, that excision alone of gastric ulcer has been too nearly completely abandoned and that this has become [illegible] it has not been realized that excision of [illegible] lesions of the lesser curvature has resulted in motor dysfunction, which has been responsible for the disap-

pointing results of excision alone. If, therefore, excision alone can be done without interfering with normal peristalsis, the operation should have [illegible] distinct field of usefulness.

CAUTERY EXCISION OF GASTRIC ULCER
Balfour's Operation

Dissect carefully the gastro-hepatic omentum overlying the ulcer (Fig. [illegible] A). Steady the area contiguous to the ulcer with Allis forceps [illegible]. The [illegible] cautery introduced in [illegible] shall burn the ulcer slowly until the stomach

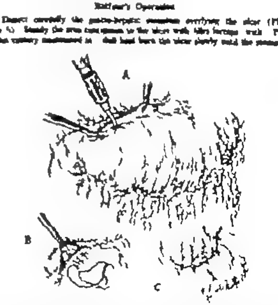


Fig. [illegible] Balfour cautery-excision operation for ulcer of the stomach. A. Lesser curvature steadied with Allis forceps; cautery destroying ulcer. B. Interrupted sutures reinforced by mattress sutures over the destroyed ulcer-bearing area. C. The suture lines are reinforced by [illegible] of [illegible] omentum held [illegible] in interrupted sutures.

has been perforated. Destroy the ulcer margins with the cautery sufficiently but not extensively. Close the opening thus created by interrupted catgut sutures, reinforced by mattress sutures of Pagenstecher linen (Fig. [illegible] B). Suture the reflected portion of the gastrohepatic omentum over the sutured area (Fig. [illegible] C).

Balfour recommends cautery excision combined with gastro-enterostomy [illegible] as an effective method in the treatment of certain types of ulcers of the [illegible] He summarized the advantages of this method in the following terms:

[illegible] D. C. Balfour, Surgical Clinics of North America [illegible]

The cautery efficiently destroys the focus of infection in gastric ulcer without the sacrifice of nature's protective induration surrounding the crater. 2. It may be applied in a large percentage of gastric ulcers. 3. It is simple, speedy and safe. 4. Clinical and roentgenologic evidence indicate that motility and function are better following excision by cautery and gastro-enterostomy than following knife excision and gastro-enterostomy. 5. The late results, if the lesion is completely removed, are at least the equal of any other method. 6. It can be used in cases in which no other means of direct attack on the ulcer is justifiable.

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Donati operation [illegible] [illegible] resection. [illegible] of the [illegible] and fingers of the left hand have been introduced along the posterior surface of the pyloric region. The [illegible] has been made [illegible] [illegible] [illegible].

Fig. [illegible] Donati operation for gastroduodenal resection. The [illegible] ligament divided and the blood vessels running [illegible] are ligated [illegible]. [illegible] of the [illegible] duodenal vessels.

It is essential that the center of the crater of the ulcer be completely perforated by the cautery. The method is most applicable to small ulcers or those involving the lesser curvature. If the crater is not more than [illegible] cm. in diameter, the cautery can be most satisfactorily used, however the extent of inflammation about the crater may be (Balfour). In ulcers of the posterior wall of the stomach the transgastric route is employed.

Donati's Technic of Gastro-duodenal Resection[1]

Professor Mario Donati's technic differs from those commonly employed. This pertains principally to the treatment of the stump of the duodenum and to the gastro-intestinal suturing. Donati prefers gastrojejunal anastomosis to gastroduodenal anastomosis. Considerable resection performed for carcinoma or for ulcer makes the approximation of the gastric stump to the duodenum, without tension, as practiced in the Billroth I procedure, particularly difficult even if the duodenum has lent itself to free mobilization. Donati admonishes that gastro-

[1] [illegible] [illegible] [illegible] [illegible] [illegible]

duodenal anastomosis should, therefore, be performed only in exceptionally favorable cases.

Fig. [illegible] Donati operation for gastroduodenal resection. After the duodenum [illegible] [illegible] [illegible] from the [illegible] and pancreatic adhesions, Donati [illegible] [illegible] [illegible] [illegible] the [illegible].

Fig. [illegible] Donati operation [illegible] gastroduodenal resection. The Donati instrument is closed [illegible] and the [illegible] carrying [illegible] [illegible] is passed through [illegible].

In carcinoma, Donati excises the great omentum as a preliminary step to the subsequent operative procedure. In resections for ulcer ablation of the omentum is not indicated, and the lesser curvature may be cut lower down [illegible] the [illegible]

Fig. [illegible] Donati operation for gastroduodenal resection. The [illegible] the [illegible] [illegible] behind the closed instrument.

Fig. [illegible] Donati operation for gastroduodenal resection. The duodenum [illegible] divided [illegible] [illegible] the instrument.

is usually made, under such circumstances, beyond the union of the vertical and horizontal portions of the lesser curvature. In gastric ulcer as well as in carcinoma of the stomach, one can usually divide and close the duodenum without difficulty. In duodenal ulcers, however, especially in those of the second portion, particularly if the ulcer is situated on its posterior wall and has invaded the pancreas, resection is an extremely difficult operation.

Regional anesthesia of the abdominal wall, by infiltration with one half per cent solution of novocaine to which has been added [illegible] cc. of vasopressin is re-

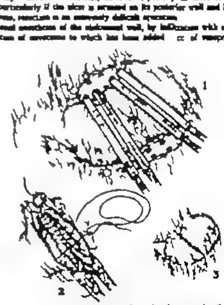


Fig. [illegible] [illegible] operation on the stomach. [illegible] Separation of the [illegible] and gastric [illegible] [illegible] corresponding to the area to be removed. [illegible] of [illegible] [illegible] [illegible] [illegible] [illegible] of the [illegible] [illegible] the [illegible] of the stomach to be removed. [illegible] [illegible] [illegible] [illegible] [illegible]. 3. Operation completed. [illegible] [illegible] of [illegible] [illegible] [illegible] [illegible] [illegible].

sorted to at times, or ether, ethylene and oxygen are used. The abdomen having been opened, ascertain the nature and the extent of the lesion, also its relations to neighboring organs. Determine the operative possibilities. As a supplementary anesthetic inject a few cubic centimeters of novocaine solution in the region of the pyloric and pancreaticoduodenal vessels and in the region of the coronary gastric artery near the lesser curvature.

Donati performed [illegible] gastro-duodenal resections (1933). In resections for carcinoma, the mortality in his series of cases has been [illegible] per cent while in resections for ulcer, the mortality was [illegible] per cent. The illustrations (Figs. [illegible]) depict, and the legends describe the further steps of his procedure.

For the anastomosis [illegible] jejunal loop is selected and pulled up through [illegible] vertical incision made in the transverse mesocolon. The left border of the divided meso-

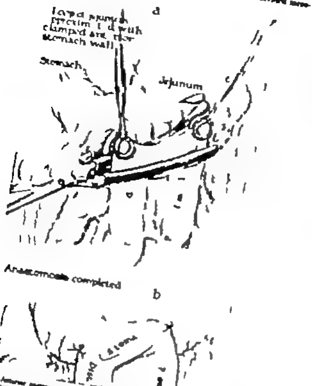


FIG. [illegible] Anterior gastrojejunostomy [illegible] a and b. A loop of jejunum [illegible]

colon is sutured to the posterior wall of the stomach. These blocked anastomosing forceps are then placed in position. One of the clamps engages the stomach, the other clamp is closed on the jejunal loop. Perform the usual form of anastomosis

[illegible] inches in length is brought from the duodenojejunal flexure anterior to the transverse colon and greater omentum and sutured to the anterior surface of the stomach in an isoperistaltic direction (Fig. [illegible]). For technic of suturing see pages 338-1345 and Figs. [illegible]

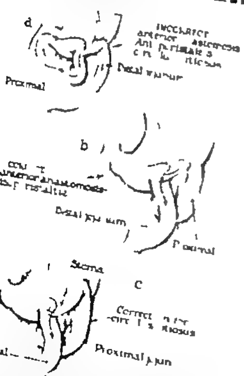


FIG. [illegible] Antiperistaltic (incorrect) anterior gastrojejunostomy [illegible] Isoperistaltic (correct) anterior gastrojejunostomy [illegible]

When the suturing is completed, the stoma should run obliquely from above downward and to the right (Fig. [illegible] b). Somewhat distant from each angle of the anastomosis [illegible] suture is placed which adds security to the attachment of the jejunum to the stomach.

beginning with [illegible] continuous seromuscular Lembert suture. The suture is extramucosal.

Anastomosis and ablation of the stomach are done next. The anterior wall of the stomach is divided further from the compression forceps than those on the anterior wall of the jejunum so as to have more tissue in front than behind. A continuous posterior suture (back stitch) is introduced next. The last stitch of the posterior suture line is knotted. Excise the segment of stomach desired. The anterior continuous suture is introduced next. The needle traverses the submucosa and the muscularis and emerges on the serous surface of the intestine a few mm. from the wound edge. After the anastomosis is completed remove the anastomosis forceps and fix the right layer of the mesocolic breach to the anterior surface of the stomach.

MIDGASTRIC (SLEEVE OR SEGMENTAL) RESECTION

The omenta (gastro-hepatic and gastro-colic) overlying the area to be removed are detached and the vessels are ligated. Isolate the diseased portion of the

FIG. [illegible] Anterior gastro-enterostomy [illegible] For technic of suturing see pages [illegible]

stomach by crushing clamps, beyond which rubber covered clamps are placed (Fig. [illegible]). Excise the affected portion of stomach. Proceed to unite both halves (end-to-end suture) as in classical gastro-enterostomy (pp. 338-1345 Figs. [illegible])

ANTERIOR GASTROJEJUNOSTOMY

Wölfler Operation

The suturing technic in the anterior operation is the same as that of the posterior procedure. In the performance of the former [illegible] loop of jejunum about

I often supplement the anterior gastrojejunostomy with [illegible] jejuno-jejunostomy (Braun-Jaboulay operation). This makes for better function. Such anastomosis between the afferent and efferent jejunal loops is done by suture or if the patient's condition demands haste, by the Murphy button (Fig. [illegible]).

Figure [illegible] depicts an incorrect, anti-peristaltic junction of the jejunum to the stomach, giving rise to [illegible] vicious circle. The arrows indicate the abdominal course of the ingesta. Compare this with Fig. [illegible] b the correct (isoperistaltic) method of gastro-enterostomy and the necessity to avoid this surgical pitfall will become apparent. If called upon to interfere surgically in such [illegible] the abdomen should promptly be opened and [illegible] (unhooking of the wrongly placed stomach) done and [illegible] of the condition accomplished by reoperating as shown in Fig. [illegible] c.

GASTRO-ENTEROSTOMIA ANTERIOR OBLIQUA

Stanischeff Operation

Professor Alex. Stanischeff called attention to the fact that vicious circle following anterior gastro-enterostomy has been almost completely eliminated by supplementing such an anastomosis with [illegible] jejuno-jejunostomy (Braun's Operation)

In the six years preceding 1928, Stanischeff performed [illegible] gastroenterostomies with and without entero-anastomosis and has endeavored to improve the technic to eliminate the necessity of [illegible] supplementary jejunojejunostomy. He believes this [illegible] accomplished by assuring an oblique direction of the stoma. He points out that an oblique opening leading from the stomach to the jejunum in anterior gastro-enterostomy as usually practiced, is not attained by the usual methods practiced which, after [illegible] time results in the stoma becoming horizontal.

In operating on patients who have undergone anterior gastro-enterostomy and where [illegible] definite attempt had been made to secure an oblique direction of the stoma, I had many opportunities to verify Stanischeff's statement that in all such cases the stoma runs in [illegible] transverse, instead of the oblique direction noted at [illegible] Stanischeff's conclusion, therefore that it is impossible to get an oblique stoma by any method now in vogue is justified.

To overcome the tendency for the stoma to become horizontal, Stanischeff devised an operation (Gastro-enterostomia anterior obliqua), the technic of which is as follows:

Step 1. Grasp the anterior wall of the stomach perpendicular to the transverse tangent of the greater curvature with rubber covered stomach clamps (Fig. [illegible]).

Step 2. Turn the handle of the stomach clamp toward the pylorus until it reaches [illegible] horizontal position (Fig. [illegible] b).

Step 3. Bring up [illegible] loop of jejunum about 40-60 cm. from the duodenojejunal flexure. Grasp it in an isoperistaltic manner with the second clamp which is placed close to and parallel with the clamp holding the segment of the anterior stomach wall.

Step 4. Perform the usual gastrojejunal anastomosis (pp. 338-1345 incl.; Figs. [illegible])

Results: [illegible]

Comment. This operation constantly results in an oblique gastro-enterostomy stoma because of traction by the ( ) stomach wall upward and ( ) the distal loop of the jejunum downward. After removal of the clamps

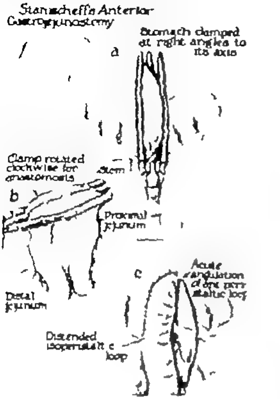


Fig. 1313. Stamscheff's [illegible] gastro-enterostomy.

the appearance of the structures is shown in Fig. 1313 c. The [illegible] loop of jejunum angulates sharply at the upper pole of the anastomosis and thus considerable closure of the afferent loop of jejunum results. The opposite results at the lower pole of the anastomosis, the efferent

portion of the jejunal loop descends vertically and forms a wide communication with the lumen of the stomach. Stamscheff (personal communication) assures me that

( ) the operation frustrates a vicious circle with certainty;

(b) it often eliminates the necessity of an additional anastomosis, hence considerable saving of time of operation;

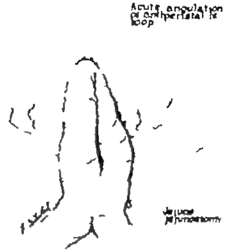


Fig. 1314. [illegible] of Stamscheff's operation which consists of anterior gastro-enterostomy with [illegible] [illegible].

(c) it requires, therefore, less anesthesia, operative shock is minimized and is of benefit to a class of patients already debilitated;

(d) it enables early postoperative drainage of the stomach.

I have used the Stamscheff procedure, following his technic meticulously, in [illegible] cases. The results were excellent. However in three cases there was postoperative vomiting and epigastric distress. It occurred to me that in view of the fact that the addition of a jejunojejunostomy in experienced hands takes but a short time to perform and is simple of execution and also because of the long loop necessary in the Stamscheff procedure (up to [illegible] cm. from the duodenojejunal junction) not being an

ideal state of affairs, that to combine Stamscheff's procedure with jejunojejunostomy would form an ideal anterior gastro-enterostomy (Fig. 1314). This I have carried out in a series of [illegible] cases. The results were perfect. *Postoperative distress was completely eliminated.*

Conclusions. Stamscheff's operation is a distinct advance over the usually practiced gastrojejunal anastomosis. It assures definitely an oblique stoma.

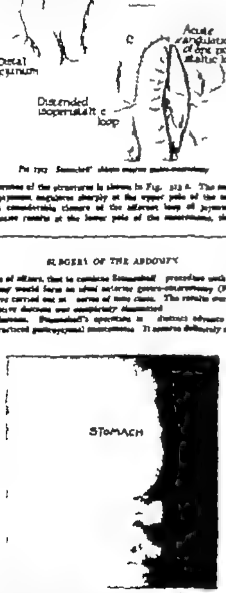


Fig. 1315. [illegible] [illegible] after Stamscheff [illegible] [illegible]

In combining Stamscheff's operation with jejunojejunostomy an ideal situation is created by eliminating congestion in the afferent loop of the jejunum and contributes to the patient's comfort and further minimizes postoperative complications (Fig. 1315).

Roux Gastrojejunostomy En Y[1]

To avoid a vicious circle following gastrojejunostomy the Roux operation found many enthusiasts. The operation has two afferent limbs[?]

Step 1. *Expose the stomach as described.*
Step [illegible]. *Open the mesocolon.*
Step 3. *Isolate and clamp an area of stomach near the greater curvature.*
Step [illegible]. *Isolate a loop of jejunum about 10 cm. long. Empty the loop of its contents and clamp it with a rubber covered intestinal clamp.*
Step 5. *Isolate the field of operation.*

Step 6. Divide the jejunum straight across, two inches distal to the upper clamped extremity.

Step 7. Anastomose the distal end of the divided jejunum into the stomach area held in the clamp (pp. [illegible] [illegible] and figs. [illegible] [illegible]).

Step 8. The anastomosis may be made either in the anterior or posterior part of the stomach. The line of incision in the stomach should equal the diameter of the intestine.

Step 9. Implant the proximal divided end into the side of the jejunum, about three inches below the site of anastomosis of the distal end of the stomach. Here the anastomosis is made vertically and equal in length to the diameter of the intestine.

Step 10. Suture the mesocolon.
Step [illegible]. Close the abdomen.

Comment. This type of operation is but seldom done. It is technically difficult. The limb of jejunum implanted in the stomach is exposed to the action of undiluted gastric juice down to the point of the lateral anastomosis with the other limb of the intestine. This greatly predisposes to gastrojejunal ulceration.

PYLORIC EXCLUSION

This procedure was introduced to surgery by Doyen and [illegible] Eiselsberg. Open the abdomen. Expose the portion of the stomach (usually the prepyloric) to be divided. Ligate and divide corresponding sections of the gastroepiploic and coronary arteries. Place a lap sponge behind the stomach. Isolate the field of operation. Apply two crushing clamps. Divide the stomach between the two. Close the open ends of the divided stomach with continuous through and through sutures (catgut). Bring both turned ends together and unite them with a seromuscular linen suture (Lembert). In some cases valvular [illegible] [illegible] the procedure was not taken. Close the divided omentum. Close the abdomen.

Kellogg's Method

Apply a stout ligature at the point of proposed exclusion (silk or chromic catgut) [illegible] [illegible] circumscribing suture, over the last contracted area. Before applying the ligature it is advisable to apply a crushing forceps and then ligate the crushed strip of stomach. Reestablishment of continuity often follows this procedure after a time. To secure permanent occlusion Kirschner used wide strips of fascia of the rectus abdominis muscle 1 cm. wide and 6 to cm. long. [illegible] Wilms made use of strips of fascia lata. After applying these fascial bands to the ribbon resulting from the crushing of the stomach, sutures passed through the fascial strip, tied and then secured in place. The results seem to be more permanent although not absolutely so.

Comment. E. L. Kellogg[1] states that the results of gastro-enterostomy are excellent in benign obstruction but much less satisfactory in non-obstructed ulcer because the greater part of the stomach contents may pass through the pylorus and prevent healing and that the gastro-enterostomy will then interfere with motility. Kellogg justly argues that under these

[1] The [illegible] [illegible] [illegible]

[illegible] pyloroplasty or pylorectomy may be preferred; also that the former may appear inadequate and the latter too radical and under these

Fig. [illegible] Pyloric exclusion. A, Strip of fascia [illegible]. [illegible] (Courtesy Dr. E. L. Eliason.)

[illegible] pyloric exclusion to supplement gastro-enterostomy should be considered.

[illegible] observes that in his experience partial and temporary blockage of the pylorus in cases in which there are nonobstructing lesions of the anterior wall of the duodenum, has definite advantages, for the reason that

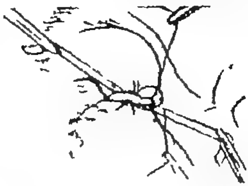


Fig. [illegible] Pyloric exclusion. [illegible] (Courtesy Dr. E. L. Eliason.)

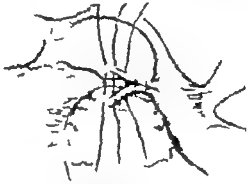


Fig. [illegible] Pyloric exclusion. [illegible] (Courtesy Dr. E. L. Eliason.)

in covering over the area of ulceration, particularly so if it is in [illegible] stage especially where perforation threatens, adequate protection against perforation is thus afforded.

To exclude the pylorus, several methods have been recommended, some

of which are major surgical procedures, while others, less radical, prove inadequate. Ligature of the pylorus with or without preliminary closure, as practiced by [illegible], is most frequently used. [illegible] formerly used double ligature of [illegible] held in place by interrupted sutures at right angles. [illegible] used metal clips. [illegible] [illegible] strip of fascia lata and [illegible], the round ligament of the liver. While ligatures may not cause permanent stenosis which will produce an occlusion that will last long enough to aid in bringing about healing of the ulcer. [illegible] ligature with kangaroo tendon produces [illegible] temporary closure of the pylorus and if this be reinforced by [illegible] band of fascia cut from the margins of the abdominal wound or by [illegible] strip of the ligamentum teres, the living tissue thus used become organized and cause permanent narrowing. And while such procedure usually fails to produce complete obstruction, it serves the purpose of diverting the greater part of the gastric contents through the stoma created by the gastrojejunostomy. (Figs. [illegible])

ANTRAL EXCLUSION

Devine's Operation

Sir Hugh B. Devine of Melbourne has pointed out that the most certain and direct means of obtaining [illegible] cure for duodenal ulcer [illegible] by excluding [illegible] from all contact [illegible] the food and gastric secretions. Antral exclusion was developed on the principles of von Eiselsberg [illegible] pyloric exclusion. The latter has been followed frequently by jejunal ulcers and has, therefore, for some years, been abandoned. The principles underlying the operation are to

a. exclude the duodenum
b. divide the stomach wall above the [illegible],
c. close the end of the lower segment and
d. complete the operation with an end-to-side gastrojejunostomy

This procedure tends to inhibit the acid-forming mechanism. The method [illegible] and much less dangerous than gastric resection and is frequently followed by excellent results. Or in the language of Devine who advocates this procedure in certain cases of penetrating ulcer, chronic duodenal ulcer and bleeding ulceration, the operative removal of which [illegible] beset with many technical difficulties, in the words of Devine, "gastric exclusion avoids the dangers of partial gastrectomy and the greater care of partial duodenectomy and obtains the same [illegible] and [illegible] reduction of acid as does [illegible] partial gastrectomy and by permanently excluding the duodenal area the [illegible] and permanent healing of the ulcer

Step [illegible] Ligate and divide the gastrohepatic and gastrocolic omenta, the gastrohepatic omentum about [illegible] inches above the [illegible], the gastrocolic omentum high enough on the greater curvature so that an oblique line of division on the stomach will result.

Step [illegible] Bare the greater and lesser curvature of omentum for a distance of about two inches.

[illegible], Gynecology & Obstetrics [illegible]

Step 3. Apply to the stomach two heavy Payr crushing clamps (Fig. [illegible]) in the proposed line of division. Divide the stomach between the clamps (Fig. [illegible]).

Step 4. Close the end of the lower segment with [illegible] continuous suture of chromic catgut.

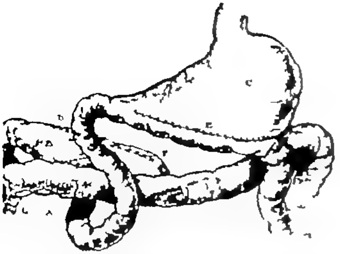
Step 5. Bring the [illegible] the upper segment of the divided stomach through an opening in the mesocolon and perform an end-to-side [illegible]-jejunostomy (Fig. [illegible]).

Fig. [illegible] Devine [illegible] operation. First stage of oblique partial antral exclusion for jejunal ulcer. Oblique division of stomach. [illegible] A, [illegible] excluded stomach. [illegible] portion of stomach [illegible] [illegible] (After Devine in Surg. Gyn. & Obst. Vol. XL [illegible] p. [illegible])

Comment. [illegible] comments on Devine [illegible] procedure as follows:

"In the rare instances in which [illegible] duodenal ulcer becomes reactivated after this operation, particularly with recurrence of bleeding, removal of the lower segment presents no particular difficulties, since the inflammatory reaction about the lesion almost completely subsides as [illegible] result of the exclusion, and mobilization is relatively easy. This [illegible] in one of our cases and we were able to bring about permanent cure by removal of the pyloric segment and [illegible] of the duodenum, as [illegible] secondary procedure. This is an [illegible] to keep in mind about all exclusion

necessity of secondary operations arises in the future, such operations can be performed without difficulty



[illegible] (After Dever et al, Surg., Gyn. & Obst., Vol. XLVII, page [illegible], 1928.)

POSTERIOR GASTROJEJUNOSTOMY

von Hacker Operation

The following factors are paramount in obtaining success with this operation

( ) A properly placed stoma;
(b) Maintenance of the original direction of the first loop of the jejunum
( ) Properly executed suturing technic and
(d) Closure of the opening in the mesocolon.

Step 1. Make an ample right paramedian incision.
Step 2. Examine the stomach, duodenum, gallbladder and appendix. Choose point on the stomach best suited for the gastro-enterostomy. This is usually best in most dependent portion of the stomach and close to the greater curvature

Step 3. Lift up the greater omentum and bring to view the transverse colon.
Step 4. Expose the transverse mesocolon by pulling on the transverse colon. *Locate the first loop of the jejunum.* This is easily accomplished by gliding the hand along the mesocolon toward its base and to the left of the median line. The location of the ligament of Treitz denotes the junction of the duodenojejunal flexure, opposite the second lumbar vertebra. If the ligament binds down the jejunum excessively or is short, it may be carefully cut between ligatures. In so doing keep in mind the position of the inferior mesenteric vein.

Where it is difficult to deliver the stomach through an opening in the mesocolon, a second opening may be made as advised by Walker in the gastrocolic omentum, and the anastomosis completed in the lesser peritoneal cavity.

Step 5. Make an opening in an avascular area of the transverse mesocolon. Avoid injury to the middle colic vessels!

Step 6. Deliver a sufficiently large portion of the posterior wall of the stomach through this opening. If, as it sometimes happens, the division of the transverse mesocolon offers some difficulty, Moynihan advises the following maneuver: Hold up the transverse colon and stomach by the left hand, making the mesocolon taut. At a bloodless spot in the arch of the middle colic artery an artery forceps is applied to the under surface of the mesocolon. Having secured a firm hold, the mesocolon is lifted from the posterior surface of the stomach and the lesser peritoneal cavity is opened at once by a snip of the scissors by the side of the artery forceps. The opening is enlarged lengthwise by gentle separation of its edges until it easily admits three fingers. The whole posterior surface of the stomach may be explored through this opening. While in the illustration it seems that the incision in the transverse mesocolon is transverse, it is actually longitudinal. It assumes a transverse aspect when the stomach is delivered as depicted.

Step 7. *Apply a stomach clamp diagonally (Mayo no-loop method) in such manner that the points of the blade are directed toward the patient's left side.* A loop of jejunum is clamped in such a manner that, when replaced to normal position, its distal portion is on a lower level than the proximal. Various clamps have been devised for gastrojejunostomy (Doyen's, Moynihan's modification of Roosevelt's, Hartmann's, Harrington, etc. Fig. 343). I use by preference Roosevelt's or its Moynihan modification, three-blade instrument. The viscera are held steady with this instrument during anastomosis. Properly used, a heavy instrument is more effective than a light one, yet the former is charged by some surgeons with being responsible for trauma.

Also, the lowest point in the proposed opening in the stomach should be at the greater curvature and run parallel to the normal direction of the first loop of the jejunum.

Allis forceps steady the stomach while a Roosevelt or single clamp are applied to the stomach, as indicated in the illustration. About three and a half inches of stomach should be in the grasp of the blade and project about an inch or more above the clamp. (Fig. [illegible])

Step 8. Suture now the proximal margin of the mesocolon to the stomach. The suturing of the mesocolon to the stomach should be done before the anasto-

mosis is made because if it is postponed until after the jejunum and stomach are sutured, the union of the mesocolon to the stomach becomes much more

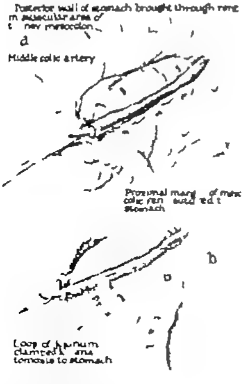


Fig. [illegible] Posterior gastroenterostomy. [illegible]

difficult and subjects the sutures already placed to undue strain. Another point emphasized by W. J. Mayo is that the margins of the rent in the meso-

colon be sutured to the stomach with interrupted sutures about half an inch above the site of the stoma. If sutured around the stoma there may result later a constriction from the contraction of the wound on the mesocolon, which may give rise to trouble. On the other hand, Moynihan prefers to attach the mesocolon to the jejunum rather than to the stomach, as generally done.

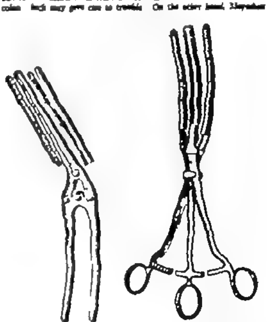


Fig. [illegible] [illegible] clamp. Fig. [illegible] Roosevelt stomach clamp.

Step 9. Clamp a loop of jejunum of the same size as the portion of stomach and approximate it to the side of the stomach in such a manner that its distal end is approximated to the greater curvature of the stomach (Fig. [illegible] b). A short proximal loop (about two or three inches), or "no loop" is now generally used to avoid "vicious circle." The importance of this has been emphasized by Petersen. I prefer to have the proximal loop sufficiently long (to cm) to perform a jejunojejunostomy should an emergency arise. Whether the jejunum is attached to the stomach, in an iso- (Moynihan) or anti-peristaltic direction (Mayo) seems, from a practical point of view, to

make no difference. Avoid inclusion of the mesentery in the clamp. "Strip" the jejunum of its contents before applying the clamp. Avoid too tight clamping, thus avoiding possible injury to the bowel wall, hematoma formation or tearing, predisposition to postoperative bleeding. Clamps, it must be remembered, are used for coaptation and not for strangulation. Moynihan's method of applying the blade of the clamps differs from that of Mayo.

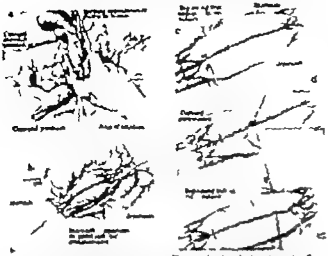


Fig. 1324. Posterior gastrojejunostomy. a. The stomach ... brought through ... [illegible]

The latter, as described, converts the application of the clamps obliquely while the former engages the stomach in a vertical direction in line with the vertical portion of the lesser curvature and ends below at the lowest point of the greater curvature. The clamp is now turned transversely, the handle of the instrument pointing to the left of the abdomen and held there by an assistant. The jejunum is picked up, also vertically by another clamp, the proximal end of which is made as near as possible before closing the blades. This ensures the inclusion of the jejunum as high as possible toward the duodeno-jejunal flexure. The clamps are now placed side by side (Fig. 1324).

Step 10. Isolate the operative field by lap sponges wrung out of warm salt

solution. A "lap-towel" with split center circumscribes the operative field. Place a towel over the handle of the clamps to prevent the sutures from catching.

Step 11. The first (approximation) suture line is a continuous suture (sero-muscular) which is non-penetrating and should include a portion of the submucous coat (recognized by its resistance to the point of the needle). I prefer for this suture Pagenstecher celluloid linen instead of catgut. It gives a greater sense of security. The suture is begun as a continuous Lembert

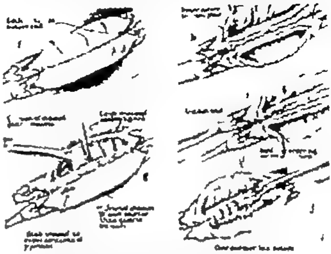


Fig. 1324 (continued). Posterior gastrojejunostomy. f. The Cushing suture is ended with ... Lembert stitch and needle ... g. The stomach ... opened and prepared for anastomosis. h. Beginning the inner suture line. i and j. Steps in placing the second (inner) suture.

last stitch as shown in Fig. 1324 e. Knot it. Place a light forceps on the short end of the suture and continue it as a Cushing suture, turning parallel to the clamps (Fig. 1324 f). It is locked at the opposite end (Fig. 1324). Another lock-stitch may be superimposed on the first one at the end of the suture line, for greater security (Fig. 1324 f). In placing this suture joining the jejunum and stomach, the suture is gently pulled upon at each passage of the needle, thus making a ridge which indicates the next point of introduction of the needle.

Step 12. Opening into the stomach and jejunum is the next step. Outline the proposed openings to be made in the stomach and jejunum by lightly scarifying the surfaces of the respective viscera, with a scalpel. The incision in

the stomach is about one-quarter of an inch from the suture line, a little shorter than its extent and running parallel with it. A suction apparatus is a convenient means of evacuating the stomach and jejunal contents if no clamps are used (Horsley). Carry the incision through the serosa and muscularis down to the submucosa. Larger vessels here encountered may now be ligated (Fig. 1324 g). An elliptic portion of mucosa (not too wide) is excised. Moynihan lays great stress on this excision of the mucosa as a prophylactic measure against subsequent contraction. The opening in the stom-

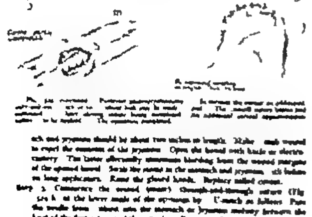


Fig. 1324 (continued). Posterior gastrojejunostomy. [illegible] The operation completed.

ach and jejunum should be about two inches in length. Make a stab wound to expel the contents of the jejunum. Open the bowel with knife or electrocautery. The latter effectually minimizes bleeding from the wound margins of the opened bowel. Swab the stoma in the stomach and jejunum with iodine on long applicators. Rinse the gloved hands. Replace soiled sponges.

Step 13. Commence the second (inner) through-and-through suture (Fig. 1324 h) at the lower angle of the openings by a U-stitch as follows: Pass the needle from without into the stomach or jejunum midway between the knot of the first suture and the cut edge. Penetrate all coats, [illegible]. Let the needle emerge from the opposite side corresponding to the point of entrance. Tie. Apply a light forceps to the short end of the su-

ture as a guide. Reintroduce the needle into the jejunum (Fig. 1324 i) and suture the posterior edges of the stomach and jejunum with an over and over lock-stitch (Fig. 1324 j) until the opposite end is reached. Here the inner suture is brought outside and tied to the first suture. The needle is then again returned to the lumen (Fig. 1324 k) and the closure of the anterior walls is continued with a Connell or as I prefer an over-and-over suture (Figs. 1324 l and m) which embraces all the coats and is, if properly applied, hemostatic, preventing hemorrhage into the stomach. The sutures should be firmly drawn by the surgeon himself and "[illegible] should not be entrusted to an assistant" (Moynihan). When reaching the knot which marks the beginning of the second (inner) suture, insert one Lembert suture just beyond the knot and tie it. Cut the ends of the suture short. It is asserted by some that silk or linen used here as an inner suture may give rise to gastro-jejunal ulceration. I use chromic catgut for this suture. Instead of a Connell suture I routinely use an over-and-over stitch as successfully practiced by Moynihan. I do not make any special effort at hemostasis of the vessels. In fact, Horsley points out that the inversion of the mucosa is a blind procedure while eversion is preferable, thus permitting careful hemostasis under direct vision.

Step 14. After finishing the second (inner row) suture, release the clamps, [illegible] and discard soiled linen and instruments. Change the field of operation. Wash or change gloves, inspect the suture line for bleeding points, pick up the long end of the outer suture and continue it with a right angle Cushing stitch to complete the operation (Fig. 1324 n). Tie it to the original short end. Place a reinforcing stitch at each angle of the suture line (Fig. 1324 o). Suture the distal margin of the mesocolon rent to the stomach at a distance from the line of anastomosis. This will prevent herniation into the lesser peritoneal sac.

Step 15. Inspect thoroughly.

Step 16. Replace the organs in proper position into the abdomen.

Step 17. Close the abdominal wall in layers.

ABLATION OF A GASTRO-ENTEROSTOMY—DEGASTRO-ENTEROSTOMIZATION

This procedure may be simple or become extremely difficult in the presence of extensive adhesions.

Operation

Expose the anastomosed area. Free it completely on all sides. Ligate the corresponding portions of the gastrocolic omentum and transverse mesocolon. Clamp the anastomosed portion of the stomach. Divide the line of anastomosis, preferably on the stomach side. Close the stomas in the stomach and jejunum in the long axis of the viscera by two layers of superimposed sutures. If the jejunum is found much narrowed, either a resection of the portion of jejunum with end-to-end anastomosis is done or a very short circuiting entero-anastomosis is performed. In the presence of gastro-jejunal ulcer the operative

technic becomes more difficult. The ulcer area may have to be resected, an end-to-end anastomosis done in the jejunum, the stomach resected to an extent indicated by the existing pathologic condition and the intestinal tube reconstructed by one of the Billroth II modification operations. If the transverse colon be involved, then it also may have to be resected, followed by an end-to-end anastomosis and complementary gastro-jejunal procedures.

BILLROTH II

This operation consists of resecting the pathologic segment of the stomach, supplemented by an anterior or posterior gastrojejunostomy with or without Braun-Jaboulay anastomosis. These procedures have in recent years given place to the modified Billroth II which will presently be described.

PARTIAL RESECTION OF THE STOMACH (GASTRECTOMY) WITH TERMINO-LATERAL GASTRO-JEJUNOSTOMY

Billroth II, Modified by Reichl, Polya, Moynihan, Balfour and Others

Step 1. Make a midline abdominal incision extending from the ensiform cartilage to the umbilical pit.

Step 2. Explore the abdomen. If done for carcinoma, avoid implantations of cancer cells by carefully packing off the abdominal viscera from the field of operation by lap sponges wrung out of warm salt solution.

Step 3. Ascertain the line of proposed resection; this should be at least one or two inches from the diseased area (to the left) and away from enlarged lymph nodes. The presence of such nodes, however, is no contraindication for operation.

Step 4. Separate the stomach from its attachments (Fig. [illegible]). This is commenced either through the lesser omentum or through the gastrocolic omentum. The latter mode of procedure will be described. Ligate doubly and divide the left gastro-epiploic vessels about the middle of the greater curvature of the stomach or more laterally to the left, if need be. Include [illegible] of the stomach wall [illegible] the bite of the needle. Leave these ligatures attached to the forceps long, to be used as tractor. Divide and ligate doubly the gastrocolic ligament. Carry this separation to the right as far as the duodenum. Avoid injury to the middle colic vessels! These supply the transverse colon and if injured, gangrene of the bowel will result. In case of carcinoma, keep close to the upper border of the transverse colon to include all lymph nodes involved. Isolate and ligate the right gastro-epiploic artery (Fig. [illegible] b) where it springs from the gastro-duodenal artery. Free the pylorus from the pancreas posteriorly. Mesially doubly ligate and divide the right gastric (coronary) artery (Fig. [illegible]). If difficulties are encountered here by reason of adhesions, the left coronary (gastric) vessels are isolated, clamped, ligated and divided and the stomach divided at this junction, between clamps, and reflected to the right. This will considerably facilitate further operative manipulations and permit the separation of the pylorus from the pancreas under direct vision. Occasionally firm adhesions are here encountered. It then becomes necessary to

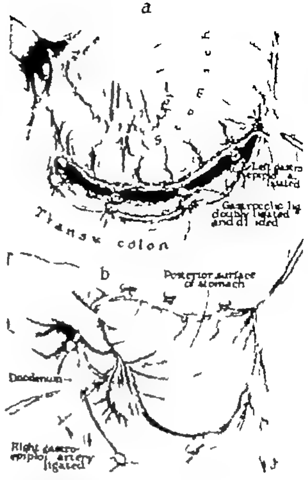


Fig. [illegible]. Partial resection of the stomach. [illegible]

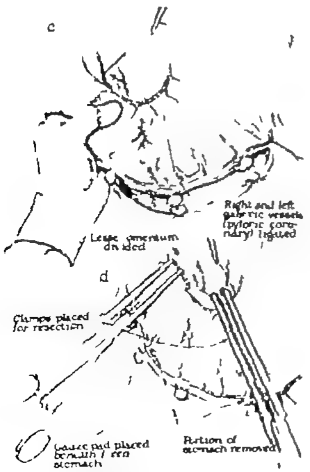


Fig. [illegible] (continued). Partial resection of the stomach. [illegible]

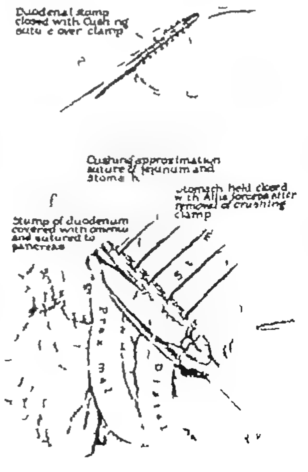


Fig. [illegible] (continued). Partial resection of the stomach. The stump of the duodenum [illegible]

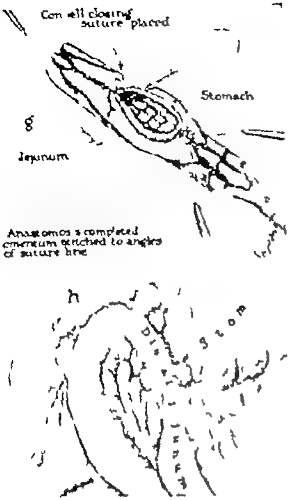


Fig. [illegible] (continued). Partial resection of the stomach. [illegible]

[illegible]

Step 3. A large lap sponge [illegible] is now placed behind the partially detached stomach.

Step 8. Two crushing clamps [illegible] are now placed at the point of proposed section of the duodenum [illegible]. Divide the duodenum with the [illegible] knife keeping close to the distal clamp.

Step 9. Apply [illegible] clamp to the distal (left) segment of the stomach (Fig. [illegible]).

Step 8. Wrap the detached pyloric end of the stomach in a hot lap sponge and turn it over to the left of the patient and proceed with the closure of the duodenum by either of the methods depicted in Figs. [illegible]

In removing the segment of stomach for carcinoma it is essential that all involved lymph nodes, particularly the subpyloric group, should be taken away.

Closure of the duodenum. The crushed end of the duodenum is closed [illegible]

[illegible]

[illegible]

[illegible]

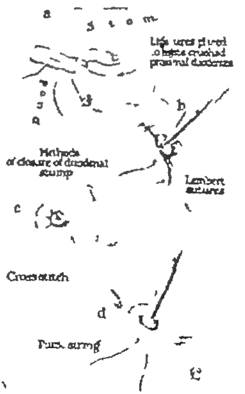


Fig. [illegible]. Methods of closure of the duodenum.

[illegible]

Step 4. *Place two crushing clamps across the stomach and divide it.*

Step 5. Close the pyloric segment below the clamp by a continuous [illegible] suture of heavy chromic catgut. Remove the clamp and continue the chromic catgut suture as a second row suture. Reinforce the suture line with interrupted silk sutures, as deemed advisable.

Step 6. Do an anterior or posterior gastrojejunostomy. If an anterior procedure is decided upon, add to it an entero-anastomosis. This completes the first step of the operation.

Proper postoperative care consists of giving the patient plenty of sodium chloride by proctoclysis (at least 2,000 cc. per diem). Gastric lavage is resorted to on the evening of the day of the operation, the following day and again after twelve hours, should there be a tendency to retention.

The second stage of the operation is performed, if no complications arise, in about a fortnight.

Second Stage

Step 1. Open the original incision.

Step 2. Mobilize the end of the pyloric stump. Ligate and divide the gastrohepatic and gastrocolic omenta and include all exposed lymph nodes.

Step 3. Divide posterior attachments and if the pancreas appears involved in the malignant infiltration, carry out the dissection with a cautery knife.

Step 4. Continue the dissection. Remove as much of extra gastric and duodenal tissue as seems necessary.

Step 5. Place a small Payr clamp on the duodenum; remove the affected segment of stomach.

Step 6. Close the duodenal stump with chromic catgut. Reinforce the suture line. Protect the stump with adjacent omental tags.

Step 7. Cleanse the field of operation carefully with warm salt solution. Close the abdominal incision with through-and-through sutures of silkworm gut.

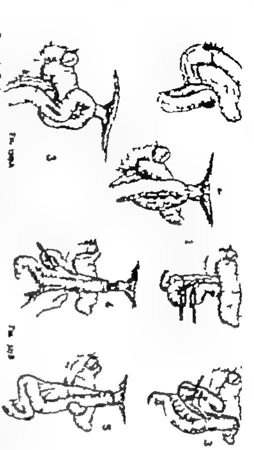
TOTAL GASTRECTOMY

This is indicated in certain forms of carcinoma of the stomach and in linitis plastica. The operation consists of removal of the whole stomach and union of the end of the esophagus with a loop of jejunum (esophagojejunostomy) or to the end or side of the duodenum (esophago-duodenostomy—Fleury). In the latter instance, free mobilization of the duodenum will facilitate the approximation of the divided ends. Where the tension between the two ends seems marked, esophagojejunostomy should be performed. This may be done in antecolic or retrocolic fashion. It may be supplemented by entero-anastomosis (Fig. [illegible]).

The actual anastomosis is performed in the usual manner. The first line of suture (seromuscular) is introduced while the stomach is being removed, as the [illegible] proceeds. A continuous inner suture follows as in other anastomoses (which see). After the suture is completed, tie the omentum to the suture line by two or three interrupted catgut stitches.

CARDIECTOMY

Access to the cardiac end of the stomach is rather difficult. If a vertical incision is used as a means of approach, it must be placed high. I prefer Mar-



wedel's incision. After the lower thorax and upper abdomen are elevated on the operating table by means of a body elevator, pneumatic pillow or sandbags, an incision, beginning at the ensiform cartilage and extending parallel with, and about two fingerbreadths below the left costal margin is made, which ends about the level of the costal cartilage of the tenth rib. The underlying soft parts are completely divided in the same direction. Expose the cartilages of the seventh, eighth and ninth ribs by dividing and retracting the overlying muscles (external and internal obliques and rectus abdominis). Divide the exposed costal cartilages and reflect the thus formed flap of chest wall which permits easy access to the left hypochondrium.

In dividing the seventh costal cartilage care should be taken not to open the pleura. The removal of the affected segment of the cardia is a difficult procedure and rests on the general principles of total gastrectomy with the difference that the esophageal end is implanted into the stomach after the tumor mass has been removed. Where the abdominal part of the esophagus cannot sufficiently be mobilized to effect a satisfactory anastomosis, the lower portion of the thoracic part will have to be utilized. To effect such mobilization, the cardiac end of the stomach and abdominal portion of the esophagus are separated from their ligamentous and vascular attachments. The vagi must be isolated and protected from injury although in advanced cases of carcinoma their division cannot always be prevented. Just as the rectum comes down for a considerable distance after the superior hemorrhoidal vessels are ligated and divided, so does the esophagus come down considerably after separation or division of the vessels and nerves.

The serous covering of the esophagus at the esophageal opening of the diaphragm is separated by incision and blunt separation and the esophagus mobilized by pulling it down by traction on the cardia. The pleura is frequently opened during this procedure—an unfortunate occurrence, particularly when no differential pressure chamber is available. Another danger is the effect on the heart and respiration through irritation of the vagi. Volcker divided both vagi and no ill results were noted. The operation is contraindicated, of course, when the operability of the tumor is questionable and when the patient's condition is poor. If deemed advisable to attempt the operation, a two-stage procedure is preferable (Kümmell). It is performed as follows: Mobilization of the esophagus; suture of its distal end over a rubber tube which is brought to the surface and there anchored by sutures. Close the stomach. Do a temporary gastrostomy. Bring the tube to the surface. Place tampons about the tubes (esophageal and gastrostomy). When healing and contraction have sufficiently progressed, a rubber T tube is made to connect the esophagus with the stomach. The patient is now fed per os. Later on, as the closure progresses, the fistula corresponding to the vertical part of the T tube is closed as a final step. When the tumor is inoperable gastrostomy should be done.

CHAPTER 34

SURGERY OF THE INTESTINES

Anatomic Considerations. The small intestine begins at the pylorus and ends at the ileocecal valve. It comprises (a) the duodenum, (b) the jejunum and (c) the ileum. It is about twenty-three feet long.

The duodenum is about ten inches long. It is the thickest and most fixed portion of the small intestine. It begins at the pylorus and ends at the duodenojejunal flexure describing an almost circular course (Fig. [illegible]).

The first part of the duodenum (pars superior) "bulb," "cap," "vestibule." The [illegible] extends to the neck of the gallbladder. It is about two inches long and extends backward, upward and somewhat to the right.

The second part (pars descendens) runs from the neck of the gallbladder to the lower border of the third lumbar vertebra. It is from three and a half to four inches in length. Its posterior surface is devoid of peritoneum and lies on the inner aspect of the right kidney. On its inner left side it is in contact with the head of the pancreas and common bile duct. The latter pierces the duodenal wall about three inches from the pylorus. The termination of the bile duct may be reached by mobilizing the duodenum by the Kocher method, which consists of incising the peritoneum on the anterior surface of the right kidney close to the right border of the duodenum above the transverse colon. The duodenum is then reflected from its bed and turned forward. The duct enters the intestinal wall after joining with the pancreatic duct to form the ampulla of Vater about [illegible] cm. from the pylorus. It must be remembered that the bile papilla is located on the posterior-internal surface of this portion of the duodenum about its middle.

The third part (pars inferior) extends to the duodenojejunal flexure on the left side of the body. It lies behind the peritoneum. It is about four inches long and horizontal (pars horizontalis).

The fourth part. The [illegible] (pars ascendens). Sometimes the pars horizontalis is absent; then the V-shaped duodenum results.

The Peritoneal Relations of the Duodenum.

First Part. The first inch of the duodenum is completely surrounded by peritoneum; the remainder of the first part, at its lower aspect, is not covered by peritoneum.

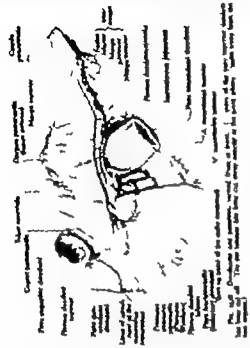
Second Part. Here the left and posterior surfaces are not covered with peritoneum.

Third Part. The upper and posterior surface of this part of the duodenum are not covered by peritoneum.

The blood supply of the duodenum consists of the superior and inferior pancreaticoduodenal arteries. The part of the duodenum above the bile papilla arises from the hepatic and is therefore supplied through the celiac axis, while the remainder arising from the midgut receives its blood supply from the superior mesenteric artery. The superior pancreaticoduodenal [illegible] branch of the superior mesenteric artery. These two arteries anastomose in a loop-like manner around the head of the pancreas. An artery supplying the anterior wall of the first part of the duodenum has been described by Wilkie—the supraduodenal artery—it springs from the hepatic or gastroduodenal artery. It is located in the anterior duodenal wall where the majority of duodenal ulcers occur.

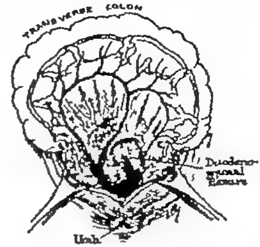
The extension of a duodenal ulcer perforating into the general peritoneal cavity descend along the right paracolic gutter. Perforating ulcers on the posterior wall of the duodenum penetrate the head of the pancreas; they sometimes erode the gastroduodenal artery or one of its branches with fatal results. Ulcers below the biliary papilla are extremely rare. The lymphatics of the duodenum drain into the nodes around the head of the pancreas.

The Duodenojejunal fossa (Fig. [illegible]) lies on the left side of the second lumbar vertebra below the pancreas in front of the left renal vessels. [illegible]



[illegible] ligament of Treitz [illegible]

[illegible] Meckel's diverticulum. [illegible]



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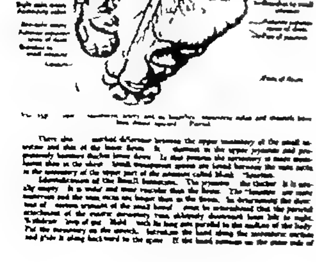


[illegible]

[illegible] The Large Intestine. [illegible]

[illegible] Ileocecal valve. [illegible]

The vermiform appendix [illegible]

(a) [illegible]

(b) [illegible]

(c) [illegible]

(d) Very long appendices may reach the rectum, ovary, tube or bladder close to Poupart's ligament.

Blood Supply of the Cecum and Appendix. The ileocolic artery springs from the superior mesenteric artery. It is retroperitoneal and after crossing the right ureter divides as it approaches the ileocecal angle into five branches: (1) anterior cecal, (2) posterior cecal, (3) colic, (4) ileac and (5) appendicular. Note: From the posterior cecal, small vessel passes to the root of the appendix. Severe hemorrhage may ensue from this source after ligating the appendicular artery during appendectomy.

In removing the cecum and ascending colon the ileocolic artery is ligated as preliminary step.

The Lymphatics of the Cecum and Appendix. The lymph vessels of the cecum and appendix drain into a group of nodes situated in the mesentery of the ileocecal angle. They accompany the ileocolic artery. There are three sets (Poirier) viz. (1) Anterior cecal, (2) Posterior cecal and (3) Appendicular lymphatics. From the ileocecal nodes the lymphatics follow the arteries to the nodes at the root of the mesentery and empty into the receptaculum chyli. They do not follow the veins to the liver; therefore, infection of the liver is not caused through the lymph channels in appendicitis. In the appendix there are three sets of lymph capillaries, subperitoneal, submucous and the mucous set (Kelly and Hurdon).

Lane's Ileal Kink, also known as Lane's Ileal Membrane, is situated in the last four inches of the ileum. It is either V or U-shaped. From the point of angulation, a band known as the ileopelvic, extends downward and fans with the parietal peritoneum from the right iliac fossa to the antimesenteric border of the ileum.

Jackson's Membrane. This thick membranous fold of peritoneum extends from the posterior abdominal wall to the right of the ascending colon. It is directed downward and inward. It is attached to the anterior longitudinal band of the cecum, or ascending colon. At this attachment, thin, long, unbranching blood vessels are seen coursing in the membrane in the direction of its course.

The three lymph streams (anterior cecal, posterior cecal, appendicular) are separate and isolated from each other and drain their respective areas only.

The ascending colon is covered anteriorly and laterally by peritoneum. Its blood supply consists of (1) the right colic and (2) ileocolic arteries, both branches of the superior mesenteric artery. It is about six inches long.

The hepatic flexure lies upon the right kidney and is covered by the liver and gallbladder. The transverse colon is about eighteen or twenty inches long. It extends from the hepatic to the splenic flexure. It is invested by the transverse mesocolon which is attached to the anterior surface of the right kidney. As it crosses the second part of the duodenum continuing along the pancreas above the duodeno-jejunal flexure, it reaches the anterior surface of the left kidney. The blood supply of the transverse colon is furnished by the middle colic, a branch of the superior mesenteric artery.

The splenic flexure is located in the left hypochondrium. It is here in relation with the tail of the pancreas and the spleen. It is situated higher and deeper in the abdominal cavity than the hepatic flexure. The phrenicocolic ligament passes from its left border to the diaphragm opposite the tenth rib.

The descending colon is about five inches long. It extends from the splenic flexure to the iliac crest where it becomes continuous with the iliac colon. It is narrower than the ascending colon and is covered by coils of small intestines. It is covered by peritoneum except posteriorly. Blood supply: Left colic and sigmoid branches of the inferior mesenteric. Occasionally the ascending and descending colons have a mesentery. The sigmoid flexure is composed of two parts, the iliac and pelvic colon. (Omega loop of Treves).

The iliac colon is 5 or 6 inches long and extends from the iliac crest to the brim of the pelvis. In the majority of cases this section of the large bowel has no mesentery. Its blood supply is the sigmoid artery.

The pelvic colon is about 7 to 19 inches long. It has a mesentery. Its terminal portion ends where the rectum begins opposite the third piece of the sacrum.

The Vessels of the Colon (Fig. 930 and Fig. 931). The superior and inferior mesenteric arteries are branches of the abdominal aorta. The superior mesenteric arises about half an inch below the celiac axis, the inferior mesenteric arises from the abdominal aorta about one and a half inches above its bifurcation.

Fig. 930. Arteries of the abdominal viscera, more superficial layer, ventral view. (The left lobe of the liver, the small intestine and the entire [illegible] have been removed, the [illegible] and [illegible] have been [illegible].) (Spalteholz.)

The lymph drainage from the large bowel (Fig. 931) to the right of the middle of the transverse colon passes into the nodes along the upper part of the superior mesenteric vessels. The rest drains to the nodes on the inferior mesenteric vessels. The efferents from the superior mesenteric nodes course to the intestinal trunk which

opens into the receptaculum chyli. The inferior mesenteric nodes drain into the left lumbar chain of nodes of the aorta.

SUTURES AND SUTURING

The best form of intestinal surgery is that which is accomplished by the simplest method. The oldest intestinal suture, or suture of the Four Masters (Salernian School in 1200) consisted essentially of a suture of the everted edges as in suture of the skin. To steady the intestine while the suture was being applied, a cylinder of cardboard or the trachea of a goose or calf was introduced into the lumen of the bowel. Duverger in 1696 made an improvement by cutting away the mucous membrane projecting from the edge of the bowel.

Lembert's principle of planar apposition (1826) and its amplification by Dupuytren (1839) in the form of a continuous suture has distinguished the French school as pioneers in this phase of intestinal surgery.

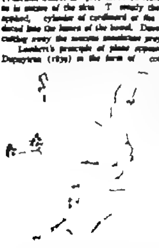


Fig. 932. Lymph glands of rectum. (After Gerota.)

REQUIREMENTS

An intestinal suture, to be successful, must fulfill the following requirements:

1. It must be secure without strangulating tissues.
2. The serous surfaces must be evenly coapted.
3. Not too much of the bowel edge should be inverted, thus predisposing to obstruction of the lumen of the bowel and
4. The junction must be watertight.

Continuous or Interrupted Sutures?

The continuous suture has the following advantages:

1. It affords greater rapidity in placement.
2. It coapts the surfaces more evenly.
3. It affords reliable hemostasis without the necessity to ligate individual vessels.
4. It forms a circular line of support to the suture itself should the bowel become distended (Jacobsen).

The disadvantages are:

1. Failure of the suture at one point jeopardizes the rest of the suture line.
2. Some believe that a continuous suture line seriously interferes with the nutrition of the segments united.

The following objections are raised to the interrupted suture:

1. It takes more time to introduce.
2. Coaptation is not as exact as with a continuous suture.
3. Hemostasis to be exact requires ligation of individual vessels.

4. The great number of knots necessary to accomplish proper union of certain segments of the intestinal tube.
5. The direction of the flow at the suture, by inhibition (the line of attraction of infection) is toward the knot. (Chlumsky). There are, of course, other suture methods (Connell, Maunsell and others) where the knot when tied is within the lumen of the bowel, but often these are not easy to carry out.

Absorbable or Non-Absorbable Suture Material

Non-absorbable sutures employed in anastomosis often tends to become extruded into the lumen of the intestine. In gastrojejunostomy it is accused of being the cause of gastrojejunal ulceration. As a general rule, I use two rows of sutures in anastomoses, an inner absorbable (catgut) and an outer nonabsorbable (silk or Pagenstecher linen). In intestinal suture particularly, this sole precaution because catgut may for one reason or another become absorbed too early and give rise to trouble.

Sutures uniting the stomach and intestine are early subjected to strain. The weakest point is at the mesenteric attachment; the strongest the submucous coat.

The solidarity of the suture line becomes progressively less during the first four days after insertion; it then gradually increases until about the eighth or tenth day when its strength equals that of the intact viscus. The third to the fifth day is the critical period for derangement of the united viscera. In view of these considerations, the importance of a properly selected diet in patients who have undergone an operation involving gastro-intestinal suture becomes apparent.

Most Important Forms of Sutures

Lembert's Suture. Originally Lembert included only the peritoneal coat and the sutures were interrupted. In time various modifications were made such as the inclusion of the muscular coat and also, later, the submucous coat.

Czerny's Suture. This method consists of first placing a row of interrupted sutures embracing all the coats of the bowel and securing the cut edges. Over this a Lembert suture is placed (Czerny-Lembert suture).

Dupuytren's Suture is a continuous Lembert suture.

Cushing's Suture (1899) is a Dupuytren suture but the needle, instead of entering the coat of the bowel transversely pierces it longitudinally in its long axis.

Halsted's mattress suture is also based on the Lembert principle. A small square of tissue is enclosed in each Halsted suture. The needle penetrates to the submucous coat. A series of short puckerings results with this suture.

A purse string suture is used mainly in inverting stumps (appendiceal, etc.), closing intestinal perforations, or closing the ends of a divided bowel before performing lateral anastomosis after enterectomy. It also is made to enter the submucous coat of the bowel.

Perforating Suture. Connell suture.

Samuel D. Gross (1843) and W. L. Halsted (1887) maintained that no

intestinal suture is safe unless all or a portion of the submucosa is included in its grasp. Since the submucosa of the small intestine is only one-sixth the thickness of the cambric needle ordinarily used in intestinal anastomosis, the [illegible] of securing all the submucosa alone without piercing [illegible] intestinal lumen becomes apparent. It is therefore necessary in order to make the anastomosis secure to penetrate all the layers of the intestine. This can be done safely. The Connell suture evolved as follows. Perforating sutures date back to [illegible] ([illegible]), Jobert ([illegible]), Gely ([illegible]), Lembert ([illegible]), [illegible] ([illegible]), Bishop ([illegible]), M. E. Connell and Maunsell ([illegible]) advocated perforating sutures. The method did not receive popular acceptance until F. G. Connell in [illegible] published his method. Hensley in [illegible] and in [illegible] used the method of perforating sutures by applying [illegible] use of [illegible] continuous sutures. Willard Bartlett ([illegible]) simplified the application of the Connell suture and proved the safety of tying the final knot on the serosa of the bowel.

Application of the Connell Suture. Secure by intestinal forceps the bowel segments to be united. Approximate the serous surfaces to each other near the open ends of the bowel. A [illegible] stitch is introduced at the mesenteric border. Apply a row of interrupted mattress sutures from the interior of the intestine including all the coats. These sutures are interrupted and knotted on the inside of the bowel. For the second half of the suture a fully curved needle should be used to close the anterior half of the anastomosis. A continuous Connell suture simplifies matters considerably.

There are many other more or less complicated methods of suturing the intestine but Moynihan admirably summed up this question in the following terms. "There are probably no pages in the history of surgery that are so [illegible] encumbered with the description of useless methods as those dealing with the subject of the suture of intestinal wounds. Of the procedures which have been advocated, [illegible] might be written, and willing and patient [illegible] have not been found wanting. It is true that there has been a constant and laudable striving after perfection, but the steps upon the road to success have been [illegible] in number and they have not all been made in a forward direction. Even at the present time this subject is not free from the [illegible] of the [illegible] [illegible] [illegible] as to the claims of his several contrivances, despite the fact that all mechanical aids to suture are unnecessary—so that one word may be summarized all that need be said of them. I do not venture to suggest that even yet any method has been advocated that will win universal acceptance. But of this there can be no question, that such a method, when established, will of necessity combine in the highest degree two essential principles—simplicity and safety. A method that is simple, and therefore quickly learned, applicable to all forms of anastomosis, quickly because of its simplicity and safe because of all its attributes, is the only one that is destined to survive."

NEEDLES

Needles for intestinal work should be round without a cutting edge. The [illegible] type straight cambric needle is excellent for intestinal work. When sutures are to be introduced into depths or into the interior of the bowel, curved needles are to be used. Needles to which the sutures are swedged are a worthwhile refinement in intestinal suturing.

In intestinal surgery all unnecessary traumatisms must be avoided. Gentle handling of tissues is paramount. Avoid pulling on the mesentery as it produces shock, besides inflicting damage to the blood vessels, giving rise to [illegible] thrombosis and [illegible] [illegible]. Hematomas, if of sufficient size, often interfere with local circulation, favoring suppurations and [illegible]. Avoid including large vessels while closing [illegible] [illegible]. Keep the operative field constantly clean by frequent changes of [illegible] [illegible]. Rinse the gloved hands

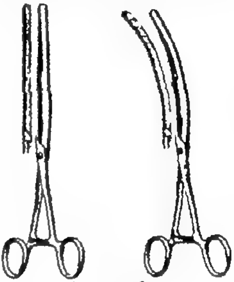


Fig. [illegible] Doyen Clamp.

when gloves should be changed after completing the inner row of sutures in an intestinal anastomosis. Contaminated instruments should also be discarded. Cover all denuded surfaces with peritoneum, wherever possible.

INTESTINAL CLAMPS

Doyen clamps are ideal and best suited for the purpose. They need not be covered with rubber; the elasticity of the blades is entirely sufficient to arrest the intestinal current (Fig. [illegible]).

The Rankin clamp or its modified pattern of Moynihan is very useful in lateral anastomosis, especially where the large intestine is included.

Other instruments used in intestinal work will be alluded to in their proper places.

Mayol ligature carrier. F. L. Mayol of Córdoba, Argentina, described a [illegible] ligature carrier for placement of double ligatures. The instrument

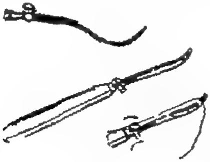


Fig. [illegible] Mayol [illegible]

[illegible] [illegible] to avoid [illegible] while [illegible] [illegible] [illegible], particularly [illegible] [illegible] [illegible] and [illegible] adhesions. The object is [illegible]—both ligatures are promptly placed thus simplifying the procedure markedly.

Fig. [illegible] Mayol ligature carrier.

Mayol's instrument depicted in Fig. [illegible] is made in the form of ligature carrier [illegible] number of sizes. It is composed of three parts. Fig. [illegible] shows the first step in the use of the instrument. The instrument [illegible] the ligature [illegible] the mesentery and delineates the vessels to be ligated. Figure [illegible] shows the loop of the suture [illegible] at the point shown in the illustration and [illegible]—thus two ligatures

[illegible] T. [illegible] No. [illegible], September, [illegible].

are at the disposal of the surgeon. Figure [illegible] shows the section of mesentery ligated, [illegible] divides the intervening tissue. The ligature carrier is so constructed that the structures in the back of the point to be [illegible] are not endangered.

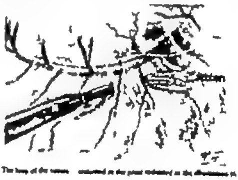


Fig. [illegible] The loop of the suture [illegible] at the point indicated in the illustration [illegible]

ENTEROTOMY AND ENTEROSTOMY

By these terms is understood the creating of an opening in any part of the intestinal tube. Special terms are used to designate the respective segment of

Fig. [illegible] Section of mesentery doubly ligated and being divided with [illegible]

bowel operated upon, as (1) duodenostomy (2) jejunostomy (3) [illegible] (4) appendicostomy (5) cecostomy (6) colostomy (7) [illegible] "Ostomies" are resorted to for the purpose of drainage

The "stomy" procedure relates to making an opening followed by immediate closure of a given intestinal segment. "Ostomies" depending on indications may be either temporary or permanent.

Enterotomy may be done for immediate evacuation and prompt closure of a given segment of bowel, the distension of which interferes with contemplated operative procedures.

An enterostomy is often performed to great advantage in cases where the bowel wall has suffered by reason of distension or direct action of toxins or as

Fig. 1395. Emptying of small bowel by "stripping" with the finger.

stoma for the introduction of nourishment into the distal segment of the bowel. It finds its greatest usefulness in acute intestinal obstruction.

ENTEROTOMY

Step 1. Draw the desired segment of bowel out of the abdominal cavity. Thoroughly protect the abdominal cavity by moist, warm lap sponges.

Step 2. Empty the bowel by "stripping" its contents between two fingers (Fig. 1395). Introduce a heavy silk ligature around the bowel but do not tie it.

Step 3. Incise the bowel on its antimesenteric border longitudinally for about an inch. Hold the edges of the incision thus made with fine vulsella forceps. Empty the lower portion of the distended bowel.

Step 4. A Moynihan tube (Fig. 1379 [illegible]) is now gently introduced into the bowel and gradually pushed upward for about three or four inches. Remove the vulsella forceps.

Step 5. Tie the ligature around the tube. With a dry gauze sponge draw the

bowel onto the glass tube within about an inch of the end to which the rubber tube is attached. An assistant now wraps a piece of gauze wrung out of hot salt solution around the tube and bowel together. This will prevent leakage

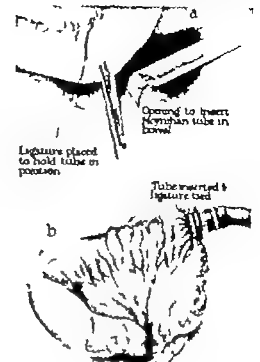


Fig. 1396. Enterotomy. a. Introducing Moynihan tube into bowel. b. Tube inserted and ligature tied.

of intestinal contents along the side of the tube. More and more of the intestine is now drawn, continuously, slowly and with utmost gentleness onto the tube by the surgeon, and while so doing, the offensive bowel contents escape through the tube into a nearby receptacle. In this way as much as 8 or 10

feet of bowel may be brought into the field of operation and thoroughly emptied (Fig. 1396 b). Moynihan admonishes that the tube must not be pushed into the bowel; the intestine must be drawn over and along it. Plenty of time must be allowed for the complete emptying of the bowel and any damage to it scrupulously avoided.

Step 6. The intestine may be washed out with saline solution in the manner advised by Moynihan, as follows: Puncture the bowel at the highest accessible point with a medium-sized needle to which a long linen rubber tube and a funnel are attached. As the salt solution runs into the bowel it grad-

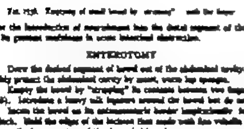


Fig. 1397. Enterotomy for the removal of a foreign body.

ually trickles downward and escapes by the rubber tube. Close the point of puncture by a few Lembert sutures or a purse-string suture including the intestinal wall.

Step 7. Replace the bowel with the exception of the segment which carries the incision which is closed by introducing an inner row of through-and-through sutures including the whole thickness of the bowel. Superimpose Lembert seromuscular sutures.

Step 8. Wash the exposed loop of bowel thoroughly with warm normal salt solution. Replace the cleansed intestine into the abdominal cavity.

Enterotomy for Removal of Foreign Bodies

Step 1. Expose the segment of bowel affected. Strip all of its contents with the fingers, as above. Apply a Doyen clamp as shown in Fig. [illegible]. Do not traumatize the bowel by too vigorous or too prolonged clamping.

Step 2. Open the bowel on its antimesenteric border with the electrosurgical knife. This minimizes bleeding, or the scalpel may be used to remove the foreign body.

3. If the incision is made in a longitudinal direction and if constriction is feared, suture it transversely with two rows of sutures, as above.

Step 4. Replace the bowel. Close the abdomen.

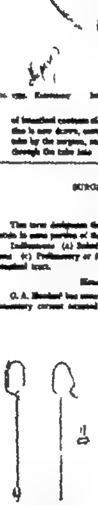
ENTEROSTOMY

This term designates the establishment of either a temporary or permanent fistula in some portion of the intestinal tube.

Indications: (a) Relief of obstruction. (b) A means of introducing nourishment. (c) Preliminary or following certain extensive operations on the gastrointestinal tract.

Kader Enterostomy Technic

G. A. Kader has since 1938 used an operation for diverting temporarily the alimentary current secured anywhere along the intestinal tube including the



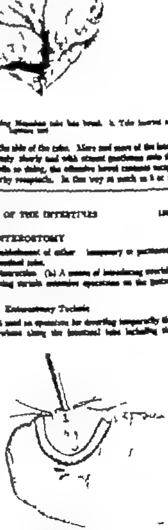


Fig. 1397 Fig. 1398

Fig. 1397. Kader method of enterostomy. a. de Pezzer catheter loaded on stylet ready for insertion. b. Specially modified stylet. c. Insertion of catheter into bowel wall and purse-string suture around.

Fig. 1398. de Pezzer catheter inserted in segment of small bowel, showing separate holes, stylet removed and purse-string sutures tied.

stomach by a procedure which he devised, the essential steps of which are as follows:

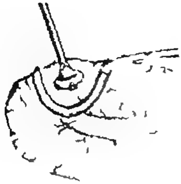
Step 1. With U-shaped forceps covered with rubber, grasp the part of the intestine chosen for the site of entry. Make a small incision into the lumen of the bowel at right angles to its long axis.

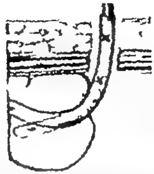
Step 2. Introduce a de Pezzer catheter upon a stylet. Insert one or two rows of purse-string sutures around the opening while the stylet is in place. Draw the sutures tight, release the spring and withdraw the stylet.

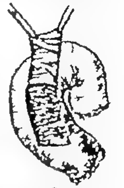
Step 3. Bring the stem of the catheter out at the lower angle of the wound or through a separate opening (Figs. 1397-1398-1399).

Comment: This operation may be used as a means of egress or ingress.

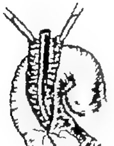
Kader, Surgery, February, 1938

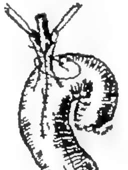


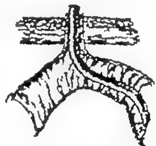




Duodenostomy







[illegible]). When gastrostomy cannot be performed in cases of extensive involvement of the stomach and esophagus.

Operations. Consist of either jejunostomy or an ileostomy. Where the large bowel is concerned colostomy is spoken of.

Witzel's jejunostomy was modified by von Eiselsberg in [illegible] and later by Maydl[?].

If the technic of the Witzel gastrostomy on page [illegible] (Fig. [illegible]) is followed, the same procedure may successfully be performed on the jejunum, ileum, or for that matter on any part of the intestinal tube, with excellent results. In brief, the operation is as follows.

Step 1. Open the abdomen on the left side.
Step 2. Deliver loop of jejunum about 20 or 30 cm. from the duodeno-jejunal flexure. Strip its contents as previously described (Fig. [illegible], p. [illegible]).
Step 3. Apply lateral clamps.
Step 4. Isolate the field of operation by moist, warm lap sponges.
Step 5. Imbed Nelaton catheter in the antimesenteric side of the bowel with Lembert sutures in such manner as to form serous lined canal hugging the catheter rather snugly. The opening of the catheter should point oralward. It is held upward by pair of forceps (Fig. [illegible] a).
Step 6. Place [illegible] suture or two a short distance from the point of the proposed opening into the jejunum which is made either with scalpel or thermocautery through which the distal end of the catheter is introduced.
Step 7. Bury the end of the catheter with few interrupted Lembert seromuscular sutures.
Step 8. Fasten the end of the catheter to the margin of the incision in the bowel by catgut suture. (This step however is not essential.) Ascertain that no obstruction in the catheter exists (introduction of some fluid).
Step 9. Suture the parietal peritoneum to the site of operation of the jejunum, using interrupted catgut sutures (Fig. [illegible] b).
Step 10. Close the abdomen.
Step [illegible]. Slip portion of rubber tube over the catheter and transfix both with a safety pin.

[illegible] METHOD

This is modification of the Witzel operation and consists of tacking the jejunum down to the [illegible]. A purse string suture is placed at the lower end of the [illegible], to be tied after the tube is projected into the bowel. A seromuscular suture covers the tube.

The same principle may be used in performing a cecostomy (Fig. [illegible]). A much larger tube, which is placed in the [illegible] longitudinally, is used here.

Mayo-Robson believes jejunostomy to be of great value in jejunal ulcer following gastro-enterostomy when the patient is too feeble to undergo [illegible] and also lends its value in ulcers near the cardiac end of the stomach along the lesser curvature and also in some ulcers of the duodenum.

The great objection to jejunostomy is the escape of bile and pancreatic juice through the fistula. This is obviated by the Maydl operation ([illegible]) which consists of dividing the jejunum transversely about 6 inches below its origin. The open end of the upper segment is implanted into the side of the lower segment and the open end of the lower segment is sutured to the skin. The principle of Maydl's procedure is identical with that of Roux' gastro-enterostomy en "Y". A just criticism of Maydl's operation is that it takes considerable time to perform and the procedure is done on patients already much exhausted by disease, [illegible] "poor operative risks," at best.

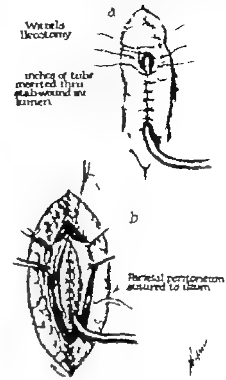


Fig. [illegible]. Witzel [illegible]

ALBERT'S METHOD

This consists of delivering sufficiently long loop of jejunum and establishing an entero-anastomosis at its base. The loop of bowel is now drawn through the fibers of the rectus abdominis muscle and then attached to the parietal peritoneum. An opening is made at the apex of the loop of bowel and tube introduced into and there fastened by one or two purse string sutures. Carnochan[?] protects the suture line in enterostomy with appendices epiploicae (Fig. [illegible]).

Mayo-Robson's method consists of jejunostomy similar to that of Albert.

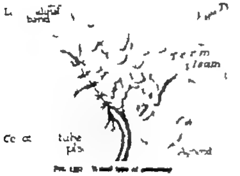


Fig. [illegible]. Witzel type of cecostomy

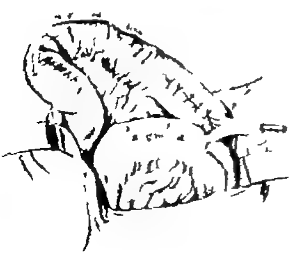


Fig. The protection of an enterostomy opening by the use of appendices epiploicae from the [illegible]. (Carnochan[?])

Appendicostomy

Indications. Appendicostomy is used (a) as means of relieving gaseous distention and for purposes of (b) lavage, medication and the introduction of nourishment into the large bowel.

Step [illegible]. Make right pararectus incision.
Step [illegible]. Expose the cecal region. Isolate the appendix. Deliver it through another smaller incision placed lateral to the first (Fig. [illegible]).

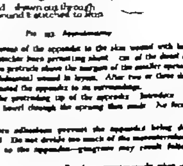


Fig. [illegible]. Appendicostomy

Step 3. Unite the serosa of the appendix to the skin wound with interrupted sutures of Pagenstecher linen permitting about [illegible] cm. of the distal extremity of the appendix to protrude above the margins of the smaller opening.
Step 4. Close the abdominal wound in layers. After two or three days adhesions will have united the appendix to its surroundings.
Step 5. Amputate the protruding tip of the appendix. Introduce Nelaton catheter into the bowel through the opening thus made. No fecal matter will escape.

Comment. Where adhesions prevent the appendix being delivered, they must be divided. Do not divide too much of the mesoappendix which carries nourishment to the appendix—gangrene may result followed by peritonitis.

The appendicostomy opening usually closes spontaneously when no longer used. If not, curettement or destruction of the mucosa [illegible] by the thermocautery will cause the opening to close.

COLOSTOMY (ANUS PRAETERNATURALIS)

Historical Notes. The operation was first suggested by Littré in 1710 in case of imperforate anus. A stoma was created in the sigmoid flexure. [illegible] performed the operation in [illegible] in 1793. The approach to the ascending colon through a lumbar incision was suggested by Callisen in 1798. [illegible] performed colostomy on the transverse colon in [illegible], while in [illegible], Amussat did an extraperitoneal right colostomy.

Colotomy was the term used for a number of centuries for the operation of creating either a temporary or permanent opening in the colon. Pétit, [illegible] proposed the term colostomy as more appropriate, and justly so, for colostomy like gastrostomy or cholecystostomy means the opening and immediate closing of [illegible] while "ostomy" designates the creation of a stoma.

Temporary sidetracking of the fecal current was first suggested by Pillore in 1884 and put in practice by Schede in 1887.

Colostomy consists of making an opening in the colon after it has been attached to the abdominal wall. Two types of colostomy are practiced: (a) temporary; (b) permanent colostomy. Either are performed above the seat of the lesion.

Indications

1. In cases of obstruction of the bowel, as a means of temporary relief (temporary colostomy).
2. To create an artificial anus in cases of malignancy of the rectum or pelvic colon (permanent colostomy).
3. In cases of volvulus accompanied by marked distention above the point of trouble (temporary colostomy).
4. In certain forms of ulcerative lesions of the large bowel (tuberculosis, dysentery) for diverting the fecal current and as an avenue for the introduction of medication.
5. In fistulous connections between the bladder and rectum.
6. In obstruction of the large bowel from extrinsic tumors and in [illegible]
7. Congenital malformations of the lower intestinal tract.

Sites of Intestinal Obstruction in Order of Frequency (Fig. [illegible]).

1. Pelvic Colon
2. Cecum
3. Splenic Flexure
4. Hepatic Flexure

Cecostomy: Ascending Colostomy

C. L. Gibson of New York suggested this operation as a means of irrigating the colon. It is now much used for decompression in various forms of intestinal obstruction.

Step 1. Make a Battle-Kammerer incision (which see, p. [illegible]).
Step 2. Deliver the [illegible] segment of bowel from the abdomen. The site for cecostomy is usually made opposite the ileocecal valve.
Step 3. If the condition calling for the operation is acute, open the bowel at

once; otherwise defer this step for 2 or 3 days and then open the bowel with scalpel or thermocautery.
Step 4. Introduce a tube into the opening thus created.
Step 5. Fasten the tube to the cecum with a catgut suture.
Step 6. Place 2 or 3 purse string sutures around the tube and proceed on the principle of the Kader Senn or Stamm gastrostomy (p. [illegible], Figs. [illegible]). Tie the sutures. This will cause a portion of the bowel to be telescoped about the catheter into the cecum. In tying the sutures be careful not to constrict the tube.

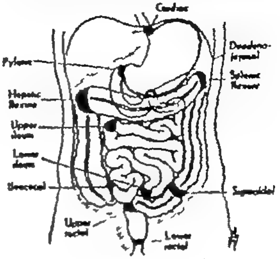


Fig. [illegible]. Diagram of typical places of intestinal obstruction.

Step 7. Fix the bowel to the parietal peritoneum and fascia.
Step 8. Close the abdominal wall in layers above and below the cecostomy opening.

Comment. The same technic is employed if the ascending colon is the segment of bowel to be operated upon.

Where it is imperative to relieve the obstruction immediately, deliver as much of the bowel into the wound as is needed for thorough work. Clamp the segment of bowel with a Doyen intestinal clamp. Exteriorize the intestine by isolating it from the general peritoneal cavity with moist hot lap sponges. Place a purse string suture around an area of the bowel in the center of which an opening is made. A Paul tube is inserted, the purse string suture tied and the abdomen closed (Fig. [illegible]).

ADVANTAGES AND DISADVANTAGES

The advantages of a cecostomy carried out two to four days before a resection of the colon or rectum are stressed by A. [illegible] Whipple.

1. It makes possible a proper cleansing of the colon before the major procedure.
2. It permits the part anastomosed to be at rest until the period of [illegible] is complete.
3. It increases the comfort of the patient by relieving distention and gases of [illegible] peristalsis.

Fig. [illegible]. Cecostomy.

4. It obviates the temptation and the necessity in some cases of giving enemas or irrigations at the critical period of repair.
5. In cases of partial or complete obstruction of the colon or rectum it has long been recognized as essential. It works as well in the patients who are desperately sick [illegible] even more efficacious in the nonobstructed case.

Whipple advocates cecostomy rather than appendicostomy for the following reasons:

1. The appendix rather [illegible] is so atrophic in adults as to be of little use as a sheath for a rubber tube.
2. A cecostomy properly done by the Kader or the Witzel method closes more promptly than an appendicostomy.
3. A tube sufficiently large to act as a real safety valve can be placed in the cecum more easily than in the appendix.

[illegible]

There are certain dangers to be avoided in the use of preliminary cecostomy:

1. The overenthusiastic use of the cecostomy tube as a means of administering fluids or enemas or irrigations before and after major procedures on the colon and rectum should be discouraged. This carries risk of leakage around the cecostomy opening and, after resection, of distending the bowel [illegible] to the suture line.
2. The tube should be kept in one position. If it comes out, it should be left out.
3. Only the most gentle syringing of the tube to dislodge fecal particles in the several [illegible] should be used.
4. Whipple found that a No. 24 F. French catheter tube of good rubber with from four to six openings in the terminal 5 cm., gives the best results as a safety valve. The Witzel method is the one of choice in introducing the tube into the cecum. The cecostomy is usually done under local anesthesia from two to three days before the major procedure.

Transverse Colostomy

There are certain operative and other advantages in performing a transverse colostomy in preference to the ones already described. The well developed mesentery of the transverse colon offers less technical difficulties. When, in performing an inguinal colostomy the mesosigmoid is too short to allow satisfactory delivery of the sigmoid flexure, transverse colostomy will solve the problem. As a matter of fact, many surgeons have, in late years, considered that colostomy in favor of this procedure claiming the following advantages:

1. A constant ease of delivery of the transverse colon and facility of operation.
2. The anus praeternaturalis in this position is cared for easier by the patient than at the classical site.
3. In some instances separated fibers of the rectus abdominis muscle may be so arranged as to form a sort of sphincter about it.
4. A retentive apparatus (colostomy bag) may be more advantageously supported by the costal arch and the upper abdominal wall.
5. Prolapse of the bowel is minimized by the direction of the pull of gravity.
6. The feces, while of sufficient consistency, are less odoriferous than in the lower sections of the bowel.
7. If the operation is for a temporary colostomy, the opening may be closed with greater facility than elsewhere (McGlone [illegible]).

Nevertheless, in order to evaluate fully both sides of the question, it must be pointed out that many surgeons prefer the sigmoid flexure for colostomy for the following reasons:

1. The sigmoid flexure has an unusually long mesentery.
2. It is easily accessible.
3. It is considered a convenient site for the anus.
4. It is more physiologic.

Emergency Colostomy

In case of doubt as to the site of obstruction the following methods are at the disposal of the surgeon to clarify the situation:

METHOD A

Abdominal exploration.
Location of the obstruction.
3. Colostomy made proximal to the obstruction.

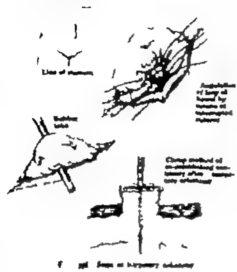


Fig. [illegible]. Steps in temporary colostomy.

METHOD B

Enter the abdomen over the region of the sigmoid.
If the obstruction lies higher up, perform an ileosigmoidostomy.

Temporary Colostomy

Step 1. Make a vertical incision about 3 inches in length the center of which passes on a line between the anterior superior spine of the ilium and the umbilicus. *Divide the rectus abdominis muscle, its fascia and peritoneum,* longitudinally. Enter the abdominal cavity and explore (Fig. [illegible]).

Step 2. Deliver the left colon which is identified by its tenuis longitudinales and appendices epiploicae. Exteriorize only that portion of the bowel directly concerned in the operation; return the rest of the bowel to the abdomen.

Step 3. *Anchor the selected section of bowel by passing interrupted sutures* of chromic catgut through the edge of the bowel about half an inch apart (Fig. [illegible]). In placing these sutures avoid the mesentery. Tie each suture after its introduction, thus creating an exteriorized loop four to five inches in length.

Step 4. *Fix the segment of bowel thus treated to the peritoneum and fascia, above and below, by interrupted sutures of Pagenstecher linen which are passed through the serous longitudinales.* An eversion of the peritoneum results which is in direct contact with the peritoneum of the bowel.

Fig. [illegible]. Steps of closure of fecal fistula and spur [illegible]. [illegible] [illegible].

Step 5. Pass a glass rod or rubber tube of appropriate size beneath the loop of bowel and fix it in place (Fig. [illegible]).

After four or five days when the bowel and peritoneum have become thoroughly adherent to one another, the sigmoid is opened transversely with the thermocautery. In urgent cases the bowel may have to be opened sooner or even at once in order to afford relief. In emergency cases the following methods may be resorted to:

1. *Suture the loop of bowel along its circumference with interrupted sutures to the skin, securely, to avoid contamination and then open it.*
Divide the bowel transversely. Suture a Paul tube into each segment.
3. Insert a Pezzer catheter of appropriate size into the knuckle of bowel and secure it with one or more purse string sutures.

CLOSURE OF ARTIFICIAL ANUS OR FECAL FISTULA

If a temporary colostomy has served its purpose, it becomes necessary to close the artificial anus. If there be no "spur" preventing the onward passage of the feces, all that may be necessary is to dissect the mucous membrane from the skin margins, invert the former toward the lumen of the bowel, uniting it with interrupted catgut sutures and suturing the skin, the edges of which have been freshened, with interrupted, nonabsorbable sutures (silk, Pagenstecher linen or fine silkworm-gut). This, as will be seen, is an extraperitoneal closure of the fistula which can only be done when the fistula is not very large.

If the fistula is large, an intraperitoneal procedure is called for and may be done as follows:

Step 1. Surround the fistulous opening with a purse-string suture of silk. Make two elliptical incisions (Fig. [illegible]) which encircle the opening lined with mucous membrane.

Step [illegible]. Deepen these incisions to the peritoneum.

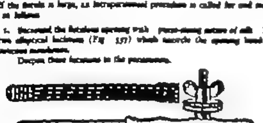


Fig. [illegible]. Colostomy Spur Crusher.

Step 3. Separate the bowel carefully from the abdominal wall and mobilize it sufficiently for thorough work. Protect the peritoneal cavity with lap sponges.

Step 4. Trim away the margins of the opening in the bowel.

Step 5. *If the loss of substance in the bowel is not too great, close the opening transversely by two rows of sutures of catgut* (Fig. [illegible]).

Step 6. Superimpose a row of interrupted sutures of Pagenstecher linen (Fig. [illegible]). If the loss of intestinal substance is great, do an enterectomy with an end-to-end anastomosis.

Step 7. Close the skin.

Where a Spur Exists (Dupuytren's Method)

Apply a clamp to the spur (Figs. [illegible]). Leave it in position until by pressure it causes the spur to slough away. After this, the barrier for the onward progress of the fecal current is removed. Follow this with a closure of the fistula by the extraperitoneal method, described above.

A special enterotome to destroy the spur is not necessary. One blade of a [illegible] inch clamp is placed in each opening of the colon and the clamp is

closed to the first notch (Fig. [illegible]). Rankin advises the use of two such clamps. Each day these are tightened one notch until the partition is cut through. The clamp usually drops out between the fifth and eighth day. Frequently such intestinal [illegible] close spontaneously.

R. Russell Best and H. Frederick [illegible] describe a new method of

Plastic Repair of a Retracted or Everted Colostomy Stoma

as follows:

Fig. [illegible]. Fig. [illegible].

Fig. [illegible]. Plastic operation for the repair of retracted and prolapsed colostomy. The stoma of the colon ... [illegible] ... surrounding [illegible].
Fig. [illegible]. Interrupted sutures for the skin margins to the tissues of the colon at the depth of the wound. (Best and [illegible].)

Step [illegible]. Irrigate the colon the night before the operation and thoroughly cleanse the skin around the stoma before the operation. A strip of gauze soaked in antiseptic solution is left in the stoma. Anesthetize the area by local infiltration.

Fig. [illegible]. Fig. [illegible].

Fig. [illegible]. Everted bowel [illegible] from [illegible] layer, everted and sutured by interrupted sutures. (Courtesy of R. R. Best.)

Step [illegible]. Make an elliptical incision around the opening, leaving about [illegible] cm. of skin margin. Grasp the gauze wick and margin of the stoma with forceps. Free and lift off the abdominal wall by traction and sharp and blunt dissection an inch or more of large bowel (Figs. [illegible]).

Step 3. Fix the freshened skin margin to the tissues of the colon at the depth of the incision by interrupted No. [illegible] chromic catgut sutures quite deep to the bowel wall but not penetrating it.

Step 4. Excise the skin attached to the colostomy stump; approximate the everted

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layer from the muscular layer by sharp dissection for a distance of 1½ inch or more in the entire circumference of the bowel (Fig. [illegible]). Evert the mucosal layer and secure it to the serosal surface of the bowel with interrupted No. [illegible] chromic catgut sutures (Fig. [illegible]).

Step 5. Lift the colon margin up from the surface of the abdominal wall for a period of four days by making a "rubber doughnut" made by tying silkworm-gut threaded through a piece of ½ inch rubber tubing long enough to surround the colostomy. Place this "doughnut" around the colostomy and secure it to the bowel at the upper and lower angles by dermal sutures which pass through the bowel wall below the margin of the everted flap and out upon the upper surface of the rubber doughnut (Fig. [illegible]).

PERMANENT COLOSTOMY

Mixter' Anterior Colostomy

Step 1. Make an incision as shown in Fig. [illegible] a. The outer portion of the incision must be a short distance inside of the outer edge of the rectus abdominis muscle. The incision divides the skin, subcutaneous fascia, and fascia of the rectus abdominis muscle.

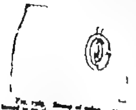


Fig. [illegible]. Stump of colon [illegible] bowel in its everted position by [illegible] two sutures through bowel wall and over to upper surface of rubber doughnut. (Courtesy of R. R. [illegible].)

Step 2. Split the rectus abdominis near its outer margin. Open the abdomen.

Step 3. Deliver the sigmoid flexure from the abdomen. Replace all excess of sigmoid upward into the abdominal cavity leaving as little bowel as possible below the exteriorized loop. In other words, the portion of bowel to be united to the abdominal wall is selected as low down as possible. In so doing, [illegible] the feces is prevented.

Step 4. Split the mesosigmoid for about two inches at a right angle to the long axis of the bowel. Suture the peritoneum, posterior fascia and the two edges of the middle portion of the separated rectus muscle together through the opening in the mesosigmoid (Fig. [illegible] b).

Step 5. Push the selected quadrangular segment of skin and rectus fascia flap through the aperture in the mesosigmoid and suture it into its original position (Fig. [illegible]).

Transsection of the Intestine. After four or five days the sigmoid end of the sigmoid may be severed by the electrocautery. Bleeding is controlled with catgut sutures. Often the heat generated by the electrocautery apparatus is sufficient to stop bleeding. The mucosa is stitched to the skin edge. The appearance of the divided ends of the bowel is as depicted in Fig. [illegible] d. The distal opening is used for irrigation—an important step in the treatment of malignancies of the rectum.

If this method is used in acute intestinal obstruction the bowel may be opened as described in the preceding paragraph and a Paul or Mixter tube inserted

Step [illegible]. Exteriorize the loop of bowel; suture in layers the peritoneum, fascia and muscle securely.

Step [illegible]. Grasp a longitudinal band of the exteriorized bowel with two forceps about [illegible] inches apart.

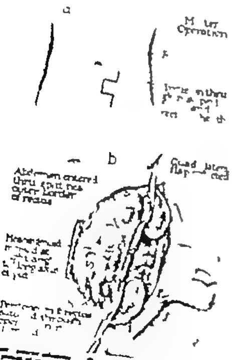


Fig. [illegible]. Mixter anterior colostomy. [illegible]

Step [illegible]. Raise the bowel upward [illegible] place a long curved clamp just below the ends of the traction forceps [illegible] then remove the bowel above beyond the margin of the clamp (Fig. [illegible]).

If it is necessary to open the bowel after a few hours for decompression, the

Difficulties and Complications

While generally speaking the average surgeon finds the performance of colostomy comparatively easy, there are, nevertheless, certain difficulties and complications encountered in this operation that often tax the resourcefulness of even experienced surgeons. Among the most troublesome conditions met with, the following need mention:

Short mesosigmoid. This may be a congenital condition or acquired by reason of inflammatory processes (mesenteritis). If such be the case the delivery of the colon or sigmoid flexure becomes difficult. A lymphangitis or lymphadenitis due to infiltration with malignant cellular elements may give rise to the same difficulty.

Adhesions between the colon and small intestine. Mixter had to deal on one occasion with adhesions between the sigmoid and the stomach and he was compelled to remove a part of the stomach wall.

3. Excessive distention or contraction of the sigmoid flexure may create great technical difficulties in performing a colostomy.

Shortness of the mesentery may be remedied by:

Incising the parietal peritoneum at its junction with the mesentery, which is then stretched.

2. Suturing the sigmoid to the parietal peritoneum and opening the bowel in the depth of the wound. This is imperative in urgent cases. The opening thus produced usually closes promptly unless supplemented, in a week or two, by a secondary operation.

3. By using the transverse colon for the same purpose. Frequently the transverse colon may be delivered through the lateral colostomy wound. If this is not possible, another incision should be made.

Complications Following Colostomy

Peritonitis. This is rare.

2. Cellulitis of the abdominal wall.

3. Retraction of the colostomy spur. When this occurs the objects of the operation are defeated. (See Bast and Eliason operation to remedy this, p. [illegible].)

4. Prolapse of the bowel.

In severe instances, ablation of the redundant mucous membrane may suffice for amelioration, or amputation of the prolapsed segment with reattachment to the skin and subcutaneous tissues may be resorted to.

In an article on "Abdominal Incisions in Lesions of the Rectum and the Rectosigmoid as Related to the Colostomy," R. Russell Best describes a

Modification of Hirschman' Technic for Opening a Colostomy which eliminates the necessity of "the patient experiencing the odor of his own burning flesh as well as the distress [illegible] such as often accompanies the grasping of bleeding points along the mesenteric border." The procedure is further simplified by combining the exteriorization of a loop of bowel with the construction of an opening, in one operation.

[illegible] Obst., [illegible] Aug. [illegible].

opening is already present, or if immediate drainage is necessary, a catheter may be passed through into the loop of bowel and immediate drainage established (Fig. [illegible]).

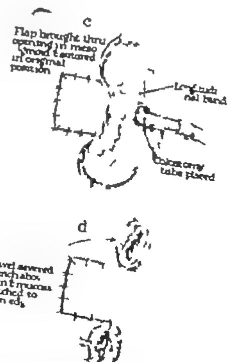


Fig. [illegible] (continued). Mixter anterior colostomy. [illegible] First stage of operation completed. Colostomy tube inserted [illegible] of acute obstruction. [illegible] the sigmoid bowel severed. If necessary the [illegible] may be stopped with [illegible] before suturing to the skin.

Postoperative Colostomy Apparatus

There are a multitude of devices on the market to be used for the reception of intestinal evacuations. These consist of belts carrying pads to occlude the

stoma in the colon or cups or bags to receive the discharges. There are also distensors for introduction into the bowel after which they are inflated with air. It takes some little time until the patient becomes accustomed to any particular mechanical contrivance (Fig. 967).

Many patients learn by careful regulation of the diet so as to control the consistency of the bowel movements and their timed evacuations as to make for a comfortable existence and for normal activities.

Fig. 967. Fig. 968.

Fig. 967. [illegible] method of temporary colostomy through left rectus. Application of crushing clamps [illegible] longitudinal division and suture of the loops with the spur. Bowel drainage [illegible] by release of the clamps [illegible] further use of the spur.
Fig. 968. The mass beyond the clamp has been excised with the cautery. Release of the clamps establishes the temporary colostomy through the left rectus. [illegible] of the proximal loop [illegible] into that loop.

When the colostomy opening is on the right side and the feces of fluid consistency [illegible] receptacle usually supplements the cup.

ENTERECTOMY

RESECTION OF THE SMALL INTESTINE

End-to-End (Axial) or Lateral Anastomosis

Indications

1. *Localized benign or malignant growths.*
2. Tuberculous lesions.
3. Gangrene of the bowel (external and internal hernias).
4. Trauma, sufficiently extensive to exclude the possibility or probability of successful enterorrhaphy, etc.
5. Irremediable strictures of the bowel.
6. Fecal fistulae not yielding to conservative and less radical operative measures.
7. Embolism or thrombosis of the mesenteric vessels.
8. Intussusceptions under certain conditions.
9. Volvulus under certain conditions.
10. Certain chronic inflammatory conditions.

Step 1. Incision—Paramedian, high or low, right or left, depending on the portion of bowel to be resected. Exposure must be ample.

Step 2. Thoroughly isolate the segment of intestine to be removed and bring it out of the abdominal cavity.

Step 3. Empty the segment of bowel of its contents by stripping it with the fingers (Fig. 970). Protect the general peritoneal cavity by means of sponges. Determine the limits of the segment of bowel to be resected. Resection must take place in healthy portions of the bowel, at [illegible] distance from the affected area. In other words, suturing in order to be effectual, must take place in tissues entirely free from inflammatory, gangrenous or otherwise diseased processes. Apply intestinal clamps (Fig. 970 a).

Step 4. Scrutinize the blood supply as it courses through the mesentery. This may be enhanced by holding the mesentery up to the light. Doubly ligate the blood vessels supplying the portion of intestine to be removed. Two sets of clamps are placed on the bowel as shown in the illustration. The mesentery is usually divided as a V-shaped segment except [illegible] short segment of bowel is to be ablated, in which case the mesentery may be divided parallel with, and close to the intestine. A ligature is placed and tied in the mesentery at the point of the V and the rest of the vessels, as already stated, ligated. Avoid the large arterial arches toward the base of the mesentery.

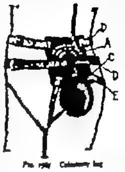


Fig. 969. Colostomy bag.

Place two ligatures close to and including [illegible] small bite of the intestinal wall, just beyond each line of section. The purpose of these is:

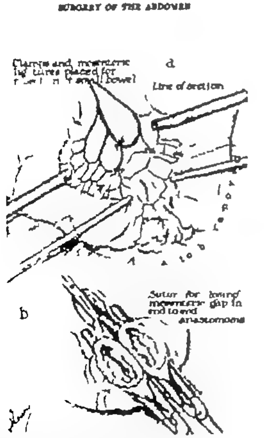
1. To close the gap in the mesentery.
2. To prevent the mesentery from slipping away from the bowel, and
3. Hemostasis.

Step 5. Divide the intestine on each side of the diseased segment in an area well supplied with blood, between the clamps placed in an oblique direction (see illustration). This will permit more of the free border of the bowel to be removed than that of the mesenteric attachment. Such oblique section offers the following advantages:

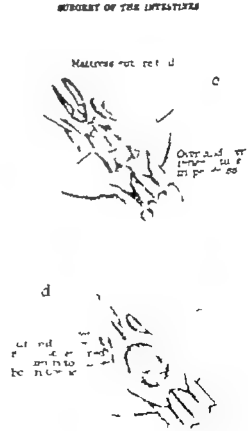
Obliquely divided ends have greater circumference than when cut transversely, thus compensating the loss of diameter occasioned by the suturing; and

Because the antimesenteric portion of the bowel is more liable to be well nourished.

Step 6. Union of the divided ends. It is essential that the intestinal ends are not traumatized by clamps, etc. Figure 970 b shows the method of introducing the mattress suture for closing the mesenteric gap. This [illegible] very important step in axial anastomosis for at this point "locus minoris resistentiae" for leakage is found, and unless properly guarded against, may



[illegible]



[illegible]

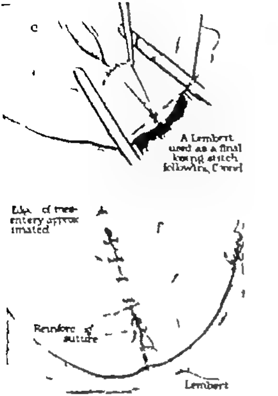


Fig. 968 (continued). Excision of [illegible] and end-to-end anastomosis. The final closing [illegible] being made. The entire bowel suture has [illegible] completed [illegible] type of reinforcing suture [illegible] which [illegible] to be considered.

lead to disastrous results. The open ends of the intestine should be cleansed (with gauze [illegible] no solution or ether). An artery forceps holds the rubber tip of the clamps in apposition, thus steadying the structures to be united.

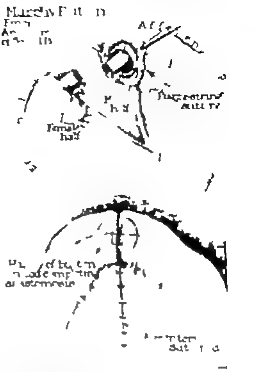


Fig. 969. Emergency Murphy button anastomosis.

Tie the mattress suture (Fig. 968) and cut its ends. Now begin the over-and-over (inner) suture at the end opposite to that at which the mattress suture has been placed and continue it as simple over-and-over or if preferred, as lock-stitch. Draw it taut after each passage of the needle. Do not allow the suture to slacken at any time.

The sutures include all the coats of the divided bowel ends and are placed between [illegible] or ¼ of an inch apart and about the same distance from the divided edge of the bowel. When reaching the mesenteric side the suture [illegible] brought out and then returned to the lumen of the bowel (Fig. 968 d) and [illegible] Connell or over-and-over suture [illegible] begun and continued all along the anterior segments of the bowel to its point of beginning. [illegible] tied, after taking [illegible] final Lembert bite (Fig. 968) and the ends cut short.

Step 7. Reinforcing Lembert-Cushing sutures (Fig. 968 f) at various points on the entire circumference of the anastomosed bowel may be introduced to good advantage.

Step 8. The opening in the mesentery is now closed as shown in the illustration. If an V-shaped resection of the mesentery has been done the redundancy [illegible] folded upon itself and secured with few interrupted sutures, taking pains not to jeopardize the nutrition of the bowel by inadvertently compromising its blood supply. When several feet of intestine have been removed, particularly [illegible] the mesentery is surcharged with fat, it is often difficult to suture the mesentery neatly and [illegible] raw surface results which will invite adhesion-formation and thus predispose to intestinal obstruction. If such be the case, ligate and remove an appropriate piece of omentum and fix [illegible] over the raw surface with [illegible] few interrupted sutures. Omental [illegible] grafts may also be used to cover denuded surfaces of bowel.

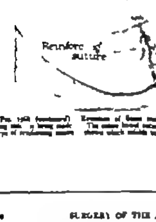


Fig. [illegible] Murphy button.

Step 9. Inspect the operative field. Cleanse. [illegible] Remove lap sponges. Return the anastomosed portion of the bowel carefully into the abdominal cavity. Close the abdominal wall. Dress the wound.

End-to-end enterostomy may also be performed by the two-suture method on the same principle as described under gastrojejunostomy (p. [illegible]). The steps of the operation are essentially those described in the preceding methods, except that the union of the bowel ends [illegible] accomplished by:

A first outer circumscribing suture of silk or Pagenstecher linen and the other second through-and-through suture (catgut).

A study of Fig. 968 in conjunction with the illustrations depicting gastrojejunostomy explains the procedure fully. Very often I give preference to the two-suture method in small anastomoses. The results are gratifying.

Intestinal Anastomosis by Means of the Murphy Button

Although suturing methods have been adopted as the ideal method for joining hollow viscera, the [illegible] use of [illegible] Murphy button and the appreciation of its invaluable use in emergencies will often save life. Where speed is paramount,

or [illegible] here sutures are difficult to introduce, the Murphy button has no equal. (Fig. 969.) It is now marketed principally in two forms (Fig. 970):

Circular for end-to-end and

Oblong for end-to-side anastomoses. They consist of two halves (male and female): the former has [illegible] spring flange which exercises pressure on the ends of the enclosed intestine, [illegible] two spiral springs which project through openings in the hollow stem, act as [illegible] thread of [illegible] screw when the male half of the button is telescoped into the female segment.

Murphy admonished that neither the button, its modifications nor suture should ever be used in end-to-end anastomoses of the large intestine (except in the rectum and sigmoid) [illegible] here an end-to-side or side-to-side anastomosis is possible, because anatomically too large an area of bowel-circumference, in these situations, is not covered by peritoneum.

Lateral Anastomosis by Means of the Murphy Button

Step [illegible]. Open the abdomen. Engage the two loops of bowel to be united and bring them out of the abdominal wound. Strip the segments of intestine of

Fig. 971. Step [illegible] method of introducing the Murphy button when there [illegible] an open end of the bowel. [illegible] single-armed Pagenstecher thread [illegible] passed in [illegible] parallel fashion [illegible] more than [illegible] quarter of an inch apart. [illegible] the passage of the suture [illegible] by the bowel being held taut by an assistant and the mesentery of the bowel [illegible] by [illegible] forceps. An incision [illegible] made between the two parallel sutures just large enough to allow the insertion of the Murphy button.

their contents. Keep them empty by Doyen clamps. Pack off the field of operation with hot, moist, lap packs.

Step 2. Introduce [illegible] purse-string suture of substantial silk or chromic catgut, preferably the former on the antimesenteric border of the intestine. The suture penetrates all the coats of the bowel. A longitudinal incision is made in the area mapped out by the purse-string suture. The longitudinal opening thus made should be sufficiently large to admit the Murphy button (Fig. 971).

Step 3. One-half of the oblong Murphy button is now seized with forceps or special forceps and its head [illegible] introduced into the opened bowel. Careless use of an artery forceps may so injure the button as to render it unusable (Note). Pull the purse-string snugly together and tie it in such [illegible] manner that the opening in the intestine is firmly fastened about the neck of the button. Any excess tissue distal to the suture is removed with knife or scissors. If precautions be not taken the proper approximation of the two halves [illegible] button may be interfered with.

Steps [illegible] and 3 are repeated on the other loop of bowel.

Step 4. Remove the forceps holding the halves of the button. *Insert the neck* of the male half of the button into that of the female half and press them together snugly. A few interrupted Lembert sutures placed here and there fortify the anastomosis.

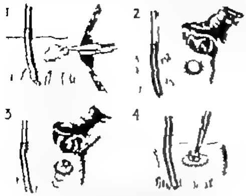


Fig. [illegible]. Method of inserting Murphy button through open end of resected bowel. Half of the button [illegible] placed in the lumen of the bowel [illegible]. The open end of the bowel has been closed and the cylinder of the Murphy button [illegible] pressed against the lateral wall of the bowel at the proposed site of anastomosis. [illegible] 3. The flaps of the [illegible] bowel are being drawn over the cylinder of the button [illegible]. The button has been drawn through the bowel, and the flange of the button [illegible] being held lightly against the [illegible] wall with [illegible] clamp. The same process [illegible] repeated on the opposite end following which the two halves of the button are clamped together. The [illegible] are not removed until after the halves of the button have been brought together. (After A. A. Berg)

End-to-End (Axial Union) by Murphy Button

This operation is practically the same as that described in the preceding paragraph.

The steps are as follows (Fig. [illegible]):

Step 1. Free [illegible] end of bowel from its contents.

Step [illegible]. Apply clamps laterally to the portion to be excised.

Step 3. Introduce [illegible] suture through the mesentery of the portion of bowel to be excised about an inch and [illegible] half from the intestinal border.

Step 4. Split the mesentery centrifugally from the intestine to the point of the ligature.

Step 5. A silk suture about ten inches long, armed with two needles, [illegible] placed making [illegible] pleat, one on either side of the intestine from the mesenteric to the free margin of the bowel. Do not draw the threads, but keep the needles in position to act as splints during the division of the bowel.

Step 6. Divide the bowel. Draw the puckering thread tight. Introduce the

button, as previously described, into the bowel. Draw the suture tight. *Knot it. Cut it short.*

Step 7. Repeat the procedure in the other end of the bowel. Introduce the other half of the button into the opposite opening in the bowel. [illegible] and treat the mesentery as indicated. Bring the two ends of the button into apposition and press them together.

Step 8. Cleanse the field. Remove the lap sponges. Close the abdomen. A great variety of contrivances have been put to use for intestinal anastomosis (decalcified bone plates (Senn); bobbins (Mayo-Robson); elastic ligature (McGraw) etc.).

Comment. Moynihan dismisses the subject of such appliances in the following terms, "The weightiest argument against all mechanical aids to anastomosis is that—they are unnecessary. By their aid we do not accomplish anything that cannot be accomplished with equal rapidity and with greater safety by the simple suture. W[illegible] have nothing to gain from their use and we risk much by leaving something, which may be, and often has been, the direct cause of danger and of death. The day of mechanical aids is over. The buttons and the bobbins, the elastic ligatures and the forceps of many forms have now no more than an historical interest."

While these statements are essentially correct, yet, I believe, that as stated at the outset, in an emergency, and in hands not highly skilled, the Murphy button still has its place.

Lateral Entero-Enterostomy

(Experimental)

The advantages ascribed to lateral (side to side) over axial (end to end) anastomosis are as follows:

1. Comparative ease of performance.
2. Less danger of primary and secondary stricture.
3. The line of anastomosis is completely surrounded by broad peritoneal surfaces, which promptly agglutinate, thus minimizing leakage and avoiding the "weak points" at the mesenteric attachment, resulting in mal-anastomosis.
4. In connecting two segments of unequal caliber it offers distinct advantages.

Treat the intestinal loops to be united as in axial anastomosis (p. [illegible]). The bowel is divided with the thermo- or electrocautery and closure of the ends of the sectioned bowel is performed as follows. The ends are turned in by basting (Kerr-Parker) stitch. This stitch is used as [illegible] gathering suture, the bowel is puckered and the two ends of the stitch are tied together. Superimpose a purse string suture which will bury the knot of the inverted basting stitch.

Technic of Closure of Ends of Divided Bowel

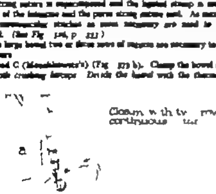
Method A (Fig. [illegible]). This is done, simply, by placing two rows of continuous suture, an inner through-and-through (catgut) suture and an outer sero-muscular *Lembert* suture (Pagenstecher linen).

Method B (Doyen's). The bowel is crushed with an écraseur or crushing

clamp, [illegible] catgut ligature is tied around the crushed ribbon of intestinal tissue. A purse string suture is superimposed and the ligated stump is inverted toward the lumen of the intestine and the purse string suture tied. As many interrupted Lembert seromuscular stitches as seem necessary are used to reinforce the closed end. (See Fig. [illegible], p. [illegible].)

In the large bowel two or three rows of sutures are necessary to obtain security of closure.

Method C (Mousseau[illegible]'s) (Fig. [illegible] b). Clamp the bowel segment to be divided with crushing forceps. Divide the bowel with the thermo- or electro-



[illegible]. Closure [illegible] divided end of bowel.

cautery knife. The cauterized end is invaginated with the clamp remaining in situ while interrupted or [illegible] continuous Lembert suture is introduced as shown in the illustration. The clamp is removed immediately before the last stitch [illegible] introduced.

Technic of the Anastomosis

Step 1. The stripped segments of bowel to be anastomosed are engaged in Doyen intestinal clamps and placed side by side in an isoperistaltic manner [illegible], the closed ends of the loop point in opposite directions or [illegible] three-bladed anastomosing clamp may be used, which grasps the bowel just above the attachment of the mesentery. Three to four inches of intestine are held in each clamp. The anastomosis should not be made too far from the closed ends, thus avoiding the formation of *cul-de-sac* pouches.

Step [illegible]. Introduce an outer seromuscular continuous suture (Lembert) of Pagenstecher linen or fine silk following the same technic as described in gastro-jejunostomy. Lock the end of the suture.

Step 3. Open the bowel with the electrocautery or [illegible] sharp scalpel. The open-

ings should be about ½ inch shorter than the seromuscular suture and placed about ¼ inch away from it. Moist gauze sponges surround the bowel segments. When soiled they are replaced with fresh ones.

Step 4. An inner [illegible] hemostatic, through-and-through suture is begun as [illegible] U-stitch and enters as [illegible] continuous manner the whole thickness of the posterior wall of the bowel segments to be joined (see above Gastrojejunostomy, p. [illegible], Fig. [illegible]). The knot of the U-stitch is tied on the outer surface of the bowel effectually closing the corner and serving as [illegible] landmark for the return stitch which embraces the whole thickness of the anterior wall of both bowel segments and is tied to the short end of the inner suture. The angle is reinforced by [illegible] superimposed Lembert stitch made with the same suture.

Step 5. Loosen the clamps. Wash off the anastomosed bowel with warm salt solution. Inspect the suture line. Change gloves. Discard soiled instruments.

Step 6. Pick up the long end of the seromuscular suture and continue it as right angle Cushing stitch (Fig. [illegible], p. [illegible]) to its starting point. Ligate it with the short end.

Step 7. Place reinforcement sutures wherever needed. Fortify the angles by lifting and anchoring the ends with interrupted sutures.

Step 8. Repair the mesentery with interrupted catgut sutures.

Step 9. Inspect. Make sure that the blood supply has not been interfered with, particularly at the ends, and that there are no tensions or kinks of the bowel or mesentery. Replace the anastomosed bowel gently. If [illegible] drain is used (seldom necessary) particularly if it be of gauze, [illegible] should be kept at safe distance from the anastomosed area.

Resection of the Proximal Duodenum and Pyloric Sphincter for Multiple Duodenal Ulcers

While the scope of this operation, Dr. T. M. Joyce[1] points out, is limited, yet [illegible] possible [illegible] "muscled out" from the embarrassing situation one faces when unsuspected contact ulcers are encountered in the course of the performance of [illegible] pyloroplasty. The operation has, therefore, [illegible] very definite place in surgery of the duodenum. In 1907 and again in January 1929 Balfour reported practically an identical operation except that he removed more of the stomach than does Joyce. In the Balfour method, 7 to 8 cm. of the stomach is removed. It is essentially Billroth I excluding the ulcer bearing duodenum. Joyce believes it unnecessary to resect the stomach except to remove the pyloric ring. It is only in this that the Joyce method differs from that of Balfour. The latter recommends simple duodenectomy for multiple ulcers calling attention to the fact that in that operation, the entire *circumference of the duodenum* is removed and stresses the desirability of this operation in which the chief reason for surgery is hemorrhage. The accompanying illustrations depict the technic of the procedure. (Figs. [illegible].)

Nissen Method of Resecting Deep-Seated Duodenal Ulcers[2]

Nissen pointed out that "Resection for Exclusion in cases of duodenal ulcer which are deeply situated, while lauded by many, has been followed by rather unpleasant experiences in other hands." Nissen did suggest palliative re-

[1] Thomas Martin Joyce, Annals of Surgery, [illegible].
[2] Nissen, [illegible], [illegible].

FIG. 1772. [illegible] (Courtesy Dr. Tina Marta [illegible], 1929.)

FIG. 1773. Second step of partial duodenectomy. [illegible] (Courtesy Dr. Tina Marta [illegible].)

perforation. In this series one patient died from perforation of the remaining ulcer, another on the eleventh day after the operation following [illegible] hemorrhage from the ulcer. Four patients had to be reoperated on for jejunal ulcer (three on his service and another one elsewhere as already reported in the Festschrift for Prof. [illegible]). It was thought that peptic ulcer may be the result of the recurrent pylorus left behind.

FIG. 1774. Method of [illegible]. [illegible] (Courtesy of Dr. Tina Marta [illegible].)

In order to avoid such occurrences, Flechan, Eck and Melchior have suggested certain procedures. Ordinarily these cases concern ulcers which penetrate into the hepatoduodenal ligament or the posterior wall of the duodenum into the head of the pancreas. The crater of the ulcer extends to the vicinity of the papilla. To close the duodenum in a typical manner under such circumstances is a difficult proposition, to say the least.

Nissen's Technic

Step 1. Mobilize the duodenum from its mesentery on both sides. Separate adhesions particularly on the anterior wall.

Step 2. Open the affected area and incise the duodenal wall in such a manner as to expose the entire ulcerated region and its crater (Fig. [illegible]).

Step 3. Divide the anterior wall of the duodenum completely (Fig. [illegible]).

Step 4. The first row of sutures embraces the anterior wall of the duodenum and the opposite distal margin of the crater of the ulcer (Fig. [illegible]).

FIG. 1777. Nissen's method of [illegible] duodenal ulcer. [illegible] (Courtesy Prof. R. Nissen.)

FIG. 1778. Nissen's method of [illegible] duodenal ulcer. [illegible] of the anterior wall of the duodenum. (Courtesy Prof. R. Nissen.)

Step 5. The second suture effects the closure of the opening of the duodenum and embraces the anterior wall of the duodenum and its oral circumference as shown in Fig. [illegible].

FIG. 1779. Nissen's method of [illegible] deep seated duodenal ulcer. [illegible] (Courtesy of Prof. R. Nissen.)

FIG. 1780. Nissen's method of [illegible] deep seated duodenal ulcer. [illegible] (Courtesy of Prof. R. Nissen.)

Step 6. Since the peritoneal covering of the pancreas is usually thickened by reason of chronic inflammation, it affords opportunity to use this membrane [illegible] row in covering the anterior wall of the duodenum (Fig. [illegible]).

Step 7. Tags of omentum may be used as a final covering over all.

Step 8. The final step consists of two-thirds resection of the stomach (Polya-Reichel).

Comment: In a period of two and one-half years, Nissen performed twenty-two duodenal resections in cases of deep-seated duodenal ulcers. Of these cases, one patient died on the second day following the operation from hemorrhage. In that instance cholecystectomy was also done for cholelithiasis. The post-mortem examination did not disclose the point from which the bleeding took place. In all other cases healing was perfect. There were no duodenal fistulas and up to the present time not a single peptic ulcer has been observed in this series of cases.

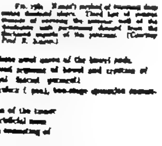


FIG. 1781. Nissen's method of treating deep seated duodenal ulcers. Third row of sutures consists of covering the anterior wall of the duodenum with peritoneum derived from the thickened capsule of the pancreas. (Courtesy Prof. R. Nissen.)

RESECTIONS OF THE LARGE BOWEL

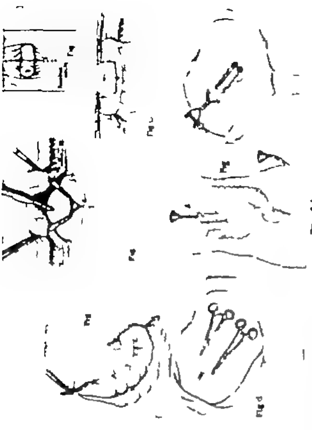
The modern methods of bowel resection are as follows:

One-stage resection with immediate end-to-end union of the bowel ends.
Primary resection of the involved segment of bowel and creation of permanent colostomy (abdominal, [illegible]).
3. Bloch ([illegible]), Paul ([illegible]), Mikulicz ([illegible]), two-stage operation consisting of
(a) Exteriorization and ablation of the tumor
(b) Removal of the resulting artificial anus.
4. Schloffer: three-stage operation consisting of
(a) Cecostomy
(b) Resection of the tumor with end-to-end anastomosis.
(c) Closure of the artificial anus.
(d) Hochenegg and Lengemann's two-stage operation consisting of
( ) Exclusion of the diseased segment.
( ) Resection of the affected area.

The location of a tumor and its relation to contiguous structures may render the removal of the affected segment very hazardous, unless mobilization of a rather large segment of the bowel carrying the tumor may be effected.

A thorough knowledge of the blood supply nourishing a given segment of bowel and the arrangement of the lymph vessels and nodes draining a certain territory is of utmost importance in successfully performing the removal of different sections of the large bowel (Figs. [illegible]).

Jamieson and Dobson have accurately described the lymph drainage of respective sections of the colon, a knowledge of which enables the surgeon to plan



the mode of attack and surgical strategy Lord Moynihan aptly states that "the surgery of carcinoma is the surgical anatomy of the lymphatic system." Jamieson and Dobson's conclusions may be summarized as follows

The lymphatics connected with any given segment of the colon correspond in their course and arrangement with the main arterial branches of supply to such segment. The course and distribution of these will, therefore, afford an all important index as to the extent of intestine, parietal peritoneum, retroperitoneal tissue, or mesentery which demands removal in order completely to extirpate the lymphatic area corresponding to a given tumor in a particular locality Four lymphatic areas are described.

1 Ileo-colic
2 Middle colic.
3 Left colic, and
4 Inferior mesenteric.

The lymph nodes connected with each area are divided in four distinct intercommunicating groups, viz

1 Epicolic nodes situated in the appendices epiploicae on the wall of the bowel
2 Paracolic, arranged parallel to the mesenteric margin of the bowel between the intestine and the arterial arcades and on the arcades.
3 Intermediate nodes arranged around the trunk of the arteries about midway between their origin and the bowel.
4 Main nodes, arranged around the main trunk of the artery near its origin

The intermediate groups receive lymph vessels from the epicolic and paracolic groups, and some vessels may pass to these directly from the bowel itself.

The main groups receive lymph vessels from the three peripheral groups and in certain regions, notably the lower part of the inferior mesenteric system, directly from the intestine itself. These are also centrally connected with the lumbar and mesenteric nodes

The mode of attack in malignancies of the large bowel depends upon

1 The extent of local involvement,
2 The position of the neoplasm in relation to its blood supply

FIG. 680A Devine's operation of defunctioning the distal colon. [illegible]

3 The extent of involvement of the lymph apparatus and
4 The physical condition of the patient in relation to the magnitude of the surgical procedure.

Removal of the Cecum and Ascending Colon—Ileocolic Resection **Anesthesia.** Wherever possible spinal anesthesia should be used

Position of the patient The right side of the body should be raised

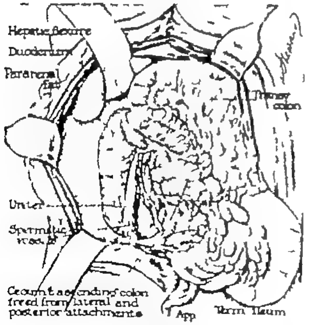


FIG. 680 Ileocolic resection

Step 1. The incision should be ample for thorough exploration and operative manipulations It should be about eight inches long, paramedian in type with displacement of the rectus abdominis muscle outward. Explore the abdomen. Orientation is essential (Fig 680)

Step 2. Pack all viscera not concerned in the operation out of the way except about 6 inches of ileum. Incise the posterior parietal peritoneum about an inch to the outer side of the cecum and ascending colon Free the cecum

from its bed by blunt (digital) dissection The "white line" represents the margin where the physiologic process ceased Gauze protected fingers dissect and mobilize the colon Hemorrhage need not be feared here because the main vessels reach the bowel from the inner aspect

Avoid the ureter during this step of the operation as well as the ovarian or spermatic vessels

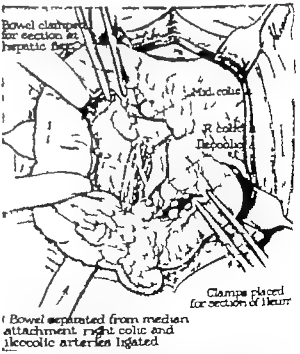


FIG. 681 Ileocolic resection

As one proceeds upward, the duodenum is exposed Mobilization is considered adequate when the hepatic flexure and the cecum are found free

Place hot lap pack behind the mobilized large bowel

Step 3. Ascertain the position of the ileocolic and right colic arteries. Instead

of attacking the ileocolic vessels from in front it is better to deal with them and the lymph structures from behind. The mobilized bowel being attached to the peritoneum only, if present, is transilluminated, to ascertain the location of the vessels concerned. Ligate the ileocolic doubly, and divide it. The right colic, if it does not originate from the ileocolic, which it usually does, is ligated separately well up at its origin.

The anastomotic branch to the transverse colon as well as the terminal branch to the ileum is also ligated. Avoid injury to the superior mesenteric artery. The parts to be removed are ablated between two clamps after dividing the mesentery or as follows (Fig. [illegible]).

The distal end of the colon may first be divided with the electrocautery and the part to be removed freed in a downward direction. While so doing the vessels are clamped at some distance from the margin of the colon before dividing them. All retroperitoneal tissues appearing involved should be carefully dissected from the posterior abdominal wall, care being taken not to injure the ureter.

Step 4. With two crushing forceps applied about an inch apart clamp the ileum about eight inches from the cecum. Divide the bowel with the electrocautery knife about an inch distal to the crushing clamps. Ordinary intestinal clamps (rubber covered) are placed distal to the crushing clamps.

Step 5. Two courses are now open:

To close both ends of the divided bowel and make a lateral anastomosis, or

To close the colic end and join the ileum with the colon (lateral implantation).

The former method is the usually accepted procedure.

Lateral anastomosis is usually made in the transverse colon, in preference to the more fixed part of the remaining ascending colon, if that part be preserved.

Close the ileum with a running suture of catgut. Invert the stump and superimpose another running suture of Pagenstecher linen. Treat the end of the divided colon, which has up to this point been kept wrapped up in moist warm lap sponge, similarly (Fig. [illegible]).

Step 6. Change soiled lap sponges and gloves. Release the clamps. Engage the portion of ileum and transverse colon to be anastomosed in Doyen intestinal or anastomosing clamps. These are to be grasped in such a manner that no pockets will remain at the ends, in other words the clamps should reach as near to the end as is consistent with safety. The closed end of the ileum is made to point to the patient's left. A stoma of about two and one-half inches is made between the ileum and transverse colon and the anastomosis accomplished by the two-row suture method (outer linen, and continuous catgut) as described in performing gastro-enterostomy or side-to-side intestinal anastomosis (pp. [illegible], Fig. [illegible]).

Step 7. Close the defect in the posterior parietal peritoneum with meticulous care for infection engrafted here may prove disastrous.

Peritonization of the denuded surface here is not always possible. Take the mesentery running from the ileum and the edge of the transverse mesocolon. If raw surface remains it is best to introduce a gutta-percha drain for a day or two.

Some surgeons prefer end-to-side anastomosis. If so, the end of the colon is closed and the end of the ileum is anastomosed to the side of the colon at the anterior taenia longitudinalis. End-to-side anastomosis may also be accomplished by the Murphy button in emergency.

Resection of the Hepatic Flexure

Position of the patient. Raise the lower thorax and upper abdomen by means of operating table elevator, air cushion, or sandbag.

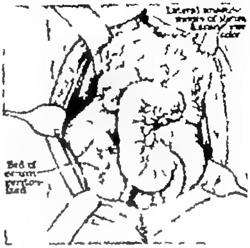


Fig. [illegible]. Hepatic resection.

Step 1. Make a right rectus incision. Deliver the segment of bowel to be resected.

Step 2. Isolate the middle colic artery and ligate it at its origin. Incise the mesentery. The upper segment of the ascending colon and about half or more of the transverse colon are removed.

Step 3. Close the ends of the bowel in a manner already described (p. [illegible]).

Step 4. Perform an ileotransversostomy.

Resection of the Transverse Colon

The technical difficulties here are not great because of good mobility by reason of a well developed mesocolon. This is especially marked on the left side. This facile mobility allows of axial anastomosis after the tumor is removed. End-to-end union is enhanced through the security offered by the peritoneum

which completely surrounds the bowel here. If preferred, a side-to-side union may be done.

The extent of the resection will necessarily depend upon the degree of the involvement of the bowel, because of the regional lymphatics and contiguous structures.

Step 1. Divide the gastrocolic omentum.

Step 2. Ascertain the extent of the bowel to be resected. Ligate all the great omentum, and remove as much of the mesentery. Deliver the section of bowel to be resected.

Step 3. Ligate the middle colic artery.

Step 4. Divide the transverse mesocolon.

Step 5. Apply two sets of clamps at each end of the transverse colon and sever the bowel (electrocautery) between the two.

Step 6. Do an end-to-end or side-to-side anastomosis.

Step 7. Reinforce the suture line with omentum.

Step 8. Close the mesocolon to shut off the lower peritoneal cavity. To gain better approximation, mobilize the hepatic and splenic flexures, if need be.

Resection of the Splenic Flexure

Here the operation is more difficult to perform because of the deep position of the flexure which is held in position by the costocolic band. A resection is inherent in about five per cent of cases. Usually about one-half of the transverse colon and a considerable portion of the descending colon are removed. According to Mayo after such resection the free mobility or facility for mobilization of the transverse colon and sigmoid flexure affords an opportunity of anastomosis between the divided proximal and distal ends in almost every case.

Step 1. Make a vertical incision. According to Mahorner an oblique incision about six inches long running along the left costal margin affords greater exposure. Whichever incision is used the important desideratum—room—should be ample. Mayo often combines transverse incisions.

Step 2. Pack off the general peritoneal cavity from the field of operation.

Step 3. Detach the omentum from the left end of the transverse colon.

Step 4. Divide the peritoneum on the outer side of the descending colon carrying the incision around the splenic flexure.

Step 5. Divide the costocolic ligament and the outer portion of the gastrocolic omentum.

Step 6. Mobilize the flexure. This is often a difficult task to perform. To accomplish it and to facilitate delivery and mobilization of the tumor the descending colon and sigmoid flexure may have to be thoroughly detached.

Step 7. Turn the detached bowel over to the right. Isolate the left colic artery divide its ascending branch between two ligatures. If the lower portion of the descending colon is also to be removed the main trunk of the left colic artery is also ligated.

Step 8. Divide the ends of the portion of bowel to be removed between two clamps placed at either end of the segment.

Step 9. Perform an axial (end-to-end) anastomosis, or a side-to-side union, after closing the ends of the severed bowel, the latter method is preferable.

Resection of the Descending Colon

Tumors in this segment are rare. Here also, exposure, mobilization and delivery of the bowel segment are rather difficult to accomplish. The steps of the operation are much the same as in the removal of the splenic flexure. Here mesentery is more frequently encountered than in the ascending colon.

Isolate the left colic artery and ligate it. The lymphatic area here consists of the epicolic and paracolic nodes and the intermediate nodes on the branches of the left colic and first sigmoid arteries (Jamieson and Dobson). The further steps are the same as described in the preceding procedure, except that the lower division consists of the upper part of the sigmoid flexure instead of the descending colon. The first sigmoid artery is ligated close to its origin. Here again, either an axial or side-to-side anastomosis is made, preferably the latter. The sigmoid flexure is mobilized and displaced upward to facilitate the anastomosis.

Resection of the Sigmoid Flexure

Malignancies in this division of the bowel are frequent. Fortunately, under well developed mesentery facilitates operative manipulation here, unless inflammatory changes or congenital cicatricial bands or a short, crippled mesentery render operation difficult.

Step 1. Place the patient in high Trendelenburg position. Spinal anesthesia is of much value.

Step 2. Make a rather long pararectus incision on the left side of the abdomen which will permit thorough exploration and operative manipulations.

Step 3. Deliver the tumor. Pack the rest of the abdominal cavity off with lap sponges. Where a long mesentery exists and the tumor is situated in the central portion of the sigmoid, delivery is easy, otherwise difficulties will present themselves. The difficulties are particularly great where the tumor is situated in the lower section of the sigmoid.

Step 4. Mobilize the bowel by incising its outer mesenteric border. This is essential. If necessary, the lower portion of the sigmoid and as much of the descending colon as needed should be mobilized. Avoid injury to the ureter and the ovarian or spermatic vessels during mobilization.

Step 5. Preserve the main trunk of the inferior mesenteric artery, the sigmoid and the superior hemorrhoidal arteries, for proper nutrition of the lower sigmoid and rectosigmoid junction.

Step 6. Apply clamps as previously described and the segment of bowel is removed together with a portion of its mesentery and such lymph nodes as are found in the involved area.

Step 7. Ligate the sigmoid arteries when encountered or preliminary to the removal of the bowel.

Step 8. Here again an axial or side-to-side anastomosis may be made. If, as frequently happens, the removal of a segment of bowel in this situation does not permit of a satisfactory anastomosis, the following procedures may be resorted to:

Rutherford Morison's Method

The lower end of the bowel is closed and its stump invaginated and colostomy is performed. The operation consists of the following essential steps:

Step 1. Excise the diseased bowel segment.
Step 2. Tie a glass bobbin to which is attached a rubber tube, into the upper end of the sigmoid flexure.
Step 3. Pass the rubber tube down, from above, through the lower divided end into the rectum; here its passage through the anus is aided by the finger of an assistant. If difficulty is encountered during this step of the operation, the assistant passes a stomach tube up from the anus into the abdomen. A piece of string is tied to the stomach tube as well as to the rubber tube and all are drawn back through the anus.
Step 4. Traction is now applied to the tube until the ligature of the upper divided end of bowel is inside of the lower cut end of bowel.
Step 5. A ligature is passed around, immediately below the lower cut end and securely tied. This renders the junction watertight.
Step 6. Further traction is now resorted to, to produce a short intussusception; this is maintained by a few Lembert sutures.

In from eight to ten days the ligated, sloughing bowel separates. The tube is then released. Some modifications of this procedure have been made by Lockhart-Mummery and Donald Balfour.

A temporary cecostomy to afford decompression and protection of the suture line is of much value in these operations.

Bloch-Paul-Mikulicz Two Stage Resection of the Large Bowel

(Also spoken of loosely as Mikulicz operation)

Historical Note. While this operation is generally credited to Mikulicz, Mayo then points out that priority belongs "beyond doubt" to F. T. Paul of Liverpool who in an article[1] gives the following description:

"Explore first in the middle line unless the stricture has been located.

"Make a sufficiently free incision over the site of the tumor.

"Having cleared away any adhesions, ligate the mesentery with the help of an aneurysm needle and divide it sufficiently to free the bowel well beyond the growth on each side.

"Let the loop of bowel containing the growth or stricture hang out of the abdomen and sew together the mesentery and the adjacent sides of the two ends. Sew first the stumps of the mesentery beneath the bowel where, if deemed advisable, it can be drained by packing cyanide gauze down into it.

"Ligate tightly a glass intestinal drainage tube into the bowel above and below the tumor and then cut away the affected part. Do not cut off first, or blood will be lost unnecessarily. Only the proximal tube is really necessary. The distal end may be closed or included in the proximal ligature.

"Close the ends of the wound with a few silkworm gut sutures, passing through all the layers of the abdominal wall; no others are necessary.

"When the operation is performed in this way all the vessels except those in the primary incision are tied before they are cut and the extraperitoneal work is rendered quite bloodless.

[1] British Medical Journal, 1895, 1, 1139

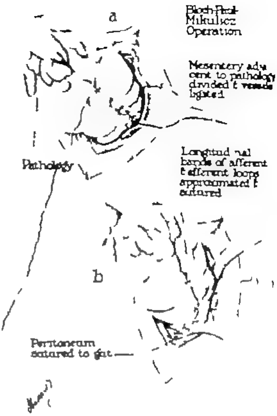


Fig. 1985. Bloch-Paul-Mikulicz operation.

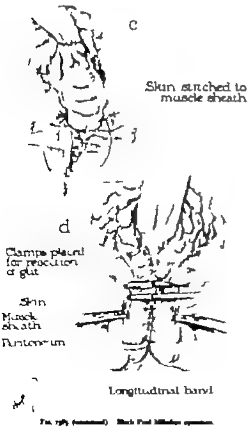


Fig. 1985 (continued). Bloch-Paul-Mikulicz operation.

"The second stage of the operation—that of breaking down the spur with an enterotome, should generally be undertaken about three weeks later. As soon as this has been satisfactorily accomplished the artificial anus is closed by separating the margins of mucous membrane from the skin, turning it in and bringing the fascial edges of the latter together over."

Priority for this operation according to Meyer belongs as stated to Paul whose procedure was described in the preceding paragraphs. In his subtle but convincing way Meyer says, "The names of many surgeons has been attached to (the operation). It has been claimed by Mikulicz whose boys were many noble hounds for Germans, by those afflicted with the quaint gallic frugality of recognition for the work of others and for surgeons in other countries."

Oscar Bloch, on October 20, 1892, read a paper before the Surgical Society of Copenhagen on Extra-abdominal Treatment of Intestinal Cancer (with the exception of the rectum). This lecture appeared in two sections in the Nord Medical Arkiv 1892, No. 1, pp. 1. An abstract of it was also printed in the Zentralblatt f. Chir. 1894, p. 608.

Late in 1894, Réclus published, in collaboration with E. Pargue, in Traité de Thérapeutique, two cases of exteriorization of the bowel which he has described. He does not mention Bloch's name. In view of the fact that Bloch's very extensive contribution to this subject appeared a year before Réclus' paper priority for this operation unquestionably should be accorded to Bloch, although in justice to Réclus it must be stated he may have thought of an exteriorization operation without knowing of Bloch's work.

Paul published his paper about nine years after the publication of Bloch's lecture, i.e. in the British Medical Journal, February 3, 1900. Paul advised division of the mesocolon, attachment of the proximal and distal loops of the bowel carrying the tumor with immediate extraperitoneal resection of the tumor mass and the introduction into each end of the bowel of a glass tube to carry off the intestinal contents, without soiling the dressings.

Despite all this, surgeons throughout the world in performing an exteriorization operation refer to it as the "Mikulicz operation." An examination of the facts discloses that Mikulicz published a description of the exteriorization of the bowel in 1902. He also says he had performed this operation since 1898. The operation consists of exteriorizing the bowel, dividing the mesocolon, followed by immediate resection of the tumor. Mikulicz spoke of the procedure in the Transactions of the Thirty-second Congress of German Surgeons, in 1903. Thus, even though Mikulicz' statement would be found to be correct, viz. that he had performed this operation since 1898, although he reported it in 1902, Bloch would still antedate him by seven years, because Bloch reported his findings to his Surgical Society in 1892.

Yet, from a careful study of the literature, Oscar Bloch[*] of Copenhagen should be accorded the credit for the procedure. The following throws an interesting side light on the question at issue. Theodor Kocher in his "Operationslehre" states: In a memorial volume dedicated to Mikulicz, Anschütz credits Oscar Bloch with having been first to propose resection of the large bowel in two stages. Bloch read his paper October 20, 1892 before the Surgical Society of Copenhagen over seven years before Mikulicz reported his procedure.

[*] See Mikulicz, "Exteriorization Operation," Max Thorek, Annals of Surgery, July, 1937; 4th Edit. Gustav Fischer, Jena, 1902, p. 907.

While Mikulicz insists that the mesentery be divided and mobilization be thorough, these are not insisted upon by other surgeons (von Schmieden).

FIG. [illegible]. Enterostomy for carcinoma of the bowel. Both clamps left in situ for [illegible] number of days. The tumor prior to its removal by thermocautery.

FIRST STAGE

Step 1. Open the abdomen. Explore thoroughly. Make sure that the tumor is operable.

Step 2. Thoroughly mobilize the intestinal segment, its mesentery and the lymph nodes to be resected. Exteriorize the involved bowel segment in such a manner that not only the projecting loops remain free from tension but that the limbs of bowel in the abdominal cavity rest against one another without pull or interference with their blood supply. The mesentery is incised and after ligating the blood vessels concerned, it is removed together with the affected lymph nodes. The afferent and efferent limbs of the intestine are now sutured through their tunicae with interrupted Pagenstecher linen sutures for about [illegible] or 3 inches (Fig. [illegible]). The mesentery should not be included in the sutured limbs of the bowel.

FIG. [illegible]. Approximation of proximal and distal segments of bowel after Bloch-Paul-Mikulicz operation. Spur to be removed later with enterotome to re-establish continuity of the bowel.

Step 3. Mobilization of the bowel must be thorough. This is often difficult particularly when tumors affect the ascending or descending colon. Here the advice of Anschütz to mobilize the bowel even as far as the transverse colon is of distinct benefit.

Unite both limbs of the sutured bowel to the parietal peritoneum, in circular manner (Fig. [illegible]).

Step 4. Close the abdominal wall in layers. Apply crushing clamps to the limbs of the bowel (von Schmieden) and remove the affected segment with the thermocautery a day or two later. The crushing clamps remain in situ until permanent agglutination has taken place (Figs. [illegible]).

A voluminous dressing supporting the bowel carrying the tumor is applied. Zinc salve or aluminum paste covers the area.

SECOND STAGE

This consists of removal of the spur (see page [illegible] under temporary colostomy) (Fig. [illegible]).

Schloffer's Three-Stage Resection

FIRST STAGE

Do [illegible] cecostomy (p. [illegible]).

SECOND STAGE

Same as Bloch-Paul-Mikulicz operation.

THIRD STAGE

Closure of some preternaturalis in the cecum.

This method is very advantageous in safeguarding the operative area by decompression, permitting irrigations to be carried out and bringing the patient into the best possible condition for the radical procedure.

RECAPITULATION

The following illustrations depict the surgical procedures in the treatment of tumors of the large intestine.

Tumor of Cecum

Area to be Resected. From about [illegible] inches distal to the ileocecal valve to about the middle of the ascending colon, or to about the left half of the transverse colon (Fig. [illegible]).

Vessels to be Ligated. Ileocolic and right colic.

Form of Anastomosis. Side-to-side ileotransversostomy.

Tumor of the Hepatic Flexure

Area to be Resected. From about 3 inches of the ileocecal valve to about the middle of the transverse colon (Fig. [illegible]).

Vessels to be Ligated. The ileocolic, right colic and middle colic arteries.

Form of Anastomosis. Side-to-side ileotransversostomy.

Tumor of the Transverse Colon

Area to be Resected. Tumor bearing segment and lateral portions (about 2 inches on either side) of healthy transverse colon (Fig. [illegible]).

Vessels to be Ligated. Branches of middle colic and left colic arteries.

Method of Anastomosis. After free mobilization, axial (end-to-end) anastomosis of the hepatic and splenic segments.

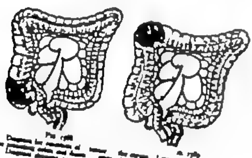


FIG. [illegible] FIG. [illegible]

FIG. [illegible]. Diagram for resection of [illegible] tumor [illegible] the cecum. Lines indicating extent of resection of the [illegible] colon and ileum [illegible] of [illegible] of the blood vessels [illegible].

FIG. [illegible]. Diagram showing area of small and large bowel to be resected in case of [illegible] tumor of the hepatic flexure of the colon.

Tumor of the Splenic Flexure

Area to be Resected. Liberal normal segment on either side of, and the tumor-bearing area (Fig. [illegible]).

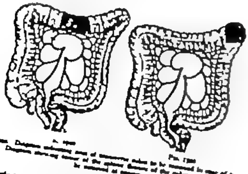


FIG. [illegible] FIG. [illegible]

FIG. [illegible]. Diagram indicating area of transverse colon to be resected in case of tumor.

FIG. [illegible]. Diagram showing tumor of the splenic flexure of the colon and area of bowel to be removed at operation.

Vessels to be Ligated. Branches of the left colic artery.

Method of Anastomosis. Side-to-side union of the remaining mobilized segments of the transverse and descending colon.

Tumor of the Descending Colon

Area to be Resected. From the outer third of the transverse colon to the beginning of the sigmoid flexure (Fig. [illegible]).

FIG. [illegible] FIG. [illegible]

FIG. [illegible]. Tumor of the descending colon. Lines indicate extent of colon to be removed.

FIG. [illegible]. Tumor of the sigmoid flexure. Diagram showing extent of bowel to be resected.

Vessels to be Ligated. Left colic artery.

Method of Anastomosis. Either axial or lateral union of the transverse colon and sigmoid flexure.

Tumor of the Sigmoid Flexure

Area to be Resected. The tumor-bearing area and about 3 or [illegible] inches on either side of it (Fig. [illegible]).

Vessels to be Ligated. Branches of the left colic, sigmoid and superior hemorrhoidal arteries.

Method of Anastomosis. Axial (end-to-end) or lateral anastomosis after thorough mobilization of the splenic flexure and descending colon (Fig. [illegible]). It is well to recall that in one-stage resections preliminary cecostomy is of great value for reasons given above.

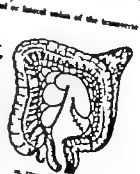


FIG. [illegible]. Outline of resection of the end-result of [illegible] tumor of the left colon after mobilization of the splenic flexure. (After Mayo.)

It must also be emphatically stated that one-stage operations unquestionably result in higher mortality than graded procedures.

One-stage operations should be done if the tumor is situated on the right side and graded operations when on the left (Victor Pauchet). The condition of the patient, the type and seat of the tumor must, of course, play an important rôle in arriving at [illegible] decision. I am in favor of graded operations.

RESECTION OF THE RECTOSIGMOID AND RECTUM

Rankin's Combined Abdominoperineal Operation in Two Stages

Fred W. Rankin[1] divides the surgical procedure into three phases: (1) preoperative preparation, (2) operative technic, and (3) postoperative treatment.

PREOPERATIVE PREPARATION

Decompression is just as essential a consideration as is the choice of operative procedure (advanced age, debilitating diseases, cachectic states). Decompression, Rankin points out, is essential because of the fact that a high percentage of all cases of sigmoidal growths produce, at some time during their presence, obstruction, subacute, chronic or acute.

When medical measures (repeated irrigations, mild purgatives) fail, surgical decompression (cecostomy, colostomy) is indicated. Rankin prefers cecostomy to colostomy.

By the use of a de Pezzer catheter for cecostomy as Rankin does, satisfactory decompression of the bowel is obtained. In acute obstruction, blind cecostomy without exploration is counseled by Rankin. At the second stage the cecostomy is [illegible] as a decompressive measure if an anastomosis is attempted; if this is not done the vent is still desirable if a combined abdominoperineal resection in one stage, following the decompression is planned. "I believe," says Rankin, "that as an alternative procedure where one explores the abdomen and finds the colon too thickened and obstructed despite the medical decompressive measures to undertake a resection or manufacture of a single-barreled colostomy, the cecostomy is most advantageous. A second stage resection, beginning from behind and going forward as in the operation I have outlined, is carried out subsequently and the cecostomy is a grateful adjunct."

During the period of decompression, besides the exhibitory measures, routine blood transfusions are given.

Anesthesia. The choice of anesthetic for combined abdominoperineal resection of the rectum is an important problem. Rankin's advocacy of spinal anesthesia as the method of choice continued unabated over a period of years until he suffered an operating room casualty which was rapidly followed by another one. In consequence his faith in its routine use was shaken. Rankin's own choice of anesthetic for the first stage of the operation (exploration of the peritoneal cavity, colostomy) is gas-oxygen-ether, or ethylene. The second stage of the operation which is begun from behind and carried forward, is done first under [illegible] anesthesia and when the patient is turned over and the abdomen is opened for a second time, then again ethylene or gas-oxygen-ether is used.

FIRST STAGE

Low midline incision. Explore for palpable metastases (liver), explore from above downward (nodes about the pancreas, aorta, bifurcation of the common iliac arteries). Explore the pelvis for deposits on the pelvic peritoneum. Lastly the growth is gently palpated for mobility and resectability. It must be remembered that ulceration and obstructive processes greatly enhance the permeability of the bowel. Sepsis becomes rampant when rude manipulations are resorted to during manual palpation of the tumor and its extension. Let me quote in

[1] Ann. Surg., 1929.

Rankin's own terms: "It is my considered opinion that peritonitis ... is the lethal factor in the majority of unsuccessful resections of the colon and rectum, more often follows spread of infected exudates by manipulation at exploration, or in the course of mobilization of the growth, than from failure of the suture line to hold."

Here the judgment of the surgeon and his experience are of paramount importance. It must be remembered that neoplasms which appear nonresectable at first exploration may become vulnerable to successful surgical attack after

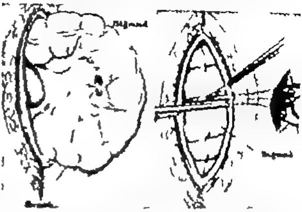


Fig. 1395. Fig. 1396.

Fig. 1395. Abdominoperineal resection of rectosigmoid and rectum. First stage. Abdomen opened through a low midline incision and sigmoid [illegible] brought out. Ligation of [illegible] vessel in the mesentery of the sigmoid close to the bowel wall. This allows [illegible] of the blood supply to both distal and proximal ends of bowel.

Fig. 1396. The sigmoid divided between Payr clamps. Proximal clamp is drawn through a stab wound in the flank and [illegible] (Courtesy Dr. Fred W. Rankin.)

decompression at the hands of the experienced surgeon. I have seen this happen in one instance the first exploration revealed an rather hopeless aspect of the situation. At the second attempt Rankin successfully resected the neoplasm in [illegible] fashion. If the surgeon finds that the neoplasm is resectable he should proceed to do a colostomy. The highest point of the most convenient portion of the sigmoid is chosen. Divide the mesentery close to the bowel (Fig. 1395). The division of the mesentery should be only sufficiently wide to permit the proximal end of the bowel to be brought out through a stab wound in the left groin. The distal end of the bowel is inverted, sutured and returned to the peritoneal cavity. Inspect the blood supply of the bowel. Figure 1396 shows the manner of division of the bowel between two Payr clamps, the upper one of which has been introduced through a stab opening in the flank and is placed at

convenient point to properly take care of a colostomy bag and only of sufficient size to permit the bowel to pass through the muscles and aponeurosis. The second clamp is shown approximating the first but in an opposite direction. Divide the bowel with cautery or electrocautery between the two clamps. Draw the proximal end through as shown in Fig. 1397, and remove the clamp at the end of forty-eight to seventy-two hours. The bowel is not sutured to the peritoneum.

All care should be directed toward the prevention of prolapse of the mucous membrane of the bowel, and herniation around the colostomy.

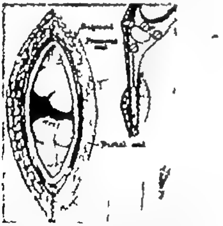


Fig. 1397. Abdominoperineal resection of rectosigmoid and rectum. First stage. Proximal end of divided bowel is drawn out through stab wound, and distal end ... Inverted ... Incision closed, and clamp holding proximal portion of sigmoid. Clamp is to be removed at end of forty-eight to seventy-two hours. (Courtesy Dr. Fred W. Rankin.)

SECOND STAGE

A month to six weeks should elapse between the two stages of operative procedure. Between stages efforts are directed toward rehabilitation of the patient and so far as possible reduction of the infection around the local growth.

About the tenth day after the operation, rectal irrigations are instituted and are continued daily up to the time of the second stage. In order to avoid undue pressure on the inverted stump, Rankin advises the use of a two-way rectal tube.

After inducing [illegible] anesthesia, begin the resection posteriorly ending up with an abdominal approach incision. Posterior partial mobilization permits extensive dissection of the pelvis up to the peritoneum. Without opening the peritoneal cavity it is possible to clean out the hollow of the sacrum and lateral fossae. The levator ani muscle is incised and the node-bearing

tissues around the prostate gland and seminal vesicles in the male and from the posterior vaginal wall, cervix, and broad ligaments in the female are cleared away.

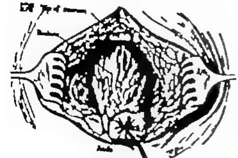
The technic is as follows: the patient is placed on the operating table, face downward as is done in posterior resections of the rectum. The hips are elevated and the anus closed with a purse string suture. Encircle the anus with two incisions which are carried upward and joined a little above the sacrococcygeal articulation (Fig. 1398). By undercutting these incisions, it is possible to clear

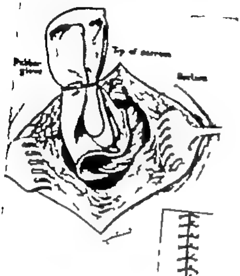
Fig. 1398. Abdominoperineal resection. (Rankin's technic.) Posterior incision for the removal of the segment of bowel left after first stage of operation. A, Position of the patient on the operating table. B, Detail of incision ... anus is purse-string closed with purse-string suture.

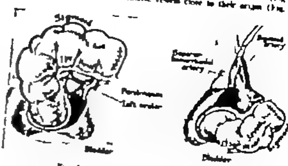
the ischiorectal tissues from fat and node-bearing tissues as much as is necessary. The coccyx is disarticulated from the sacrum. The fascia propria opposite the sacrococcygeal articulation is divided. Blunt dissection of the hollow of the sacrum follows. Lateral dissection is carried completely up to the peritoneum, which is not opened (Fig. 1399).

Encase the rectum in a rubber glove (Fig. 1400); tie it snugly around the cuff, and push it back into the hollow of the sacrum; close the posterior wound. The peritoneum has thus far not been opened.

Turn the patient and proceed to carry out the anterior part of the dissection. Reopen the low midline incision which was used originally for exploration. Enlarge it as outlined from the symphysis to an inch above and to the left of the umbilicus. Do not explore. Pack the pelvis off carefully with lap sponges wrung out of salt solution. look for the turned in end of the bowel. Incise the peritoneum over the inferior mesenteric vessels; identify both ureters. The left







POSTOPERATIVE TREATMENT

Rankin' Obstructive Resection Operation of the Colon

second, obstruction even of a low grade and third, its application to carcinoma of the colon with short mesentery in obese patients with thick abdominal walls.

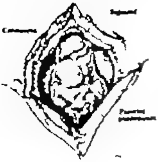


Fig. 1864

Fig. 1865

Fig. 1864. Rankin's obstructive-resection operation (in two stages). First stage—abdominal incision exposing carcinoma of the sigmoid. (Rankin.)

Fig. 1865. Beginning mobilization of neoplasm. Incising the lateral parietal peritoneum which frees the growth and allows its outward transfer. There are no blood vessels in this parietal layer. (Rankin.)

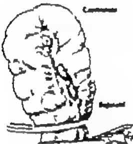


Fig. 1866

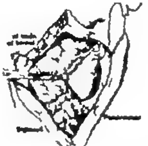


Fig. 1867

Fig. 1866. Mobilization completed. The mesenteric blood vessels are ligated and ... segment of mesentery ... The growth ... brought between clamps to be removed with ... (Rankin.)

Fig. 1867. The clamp ... The growth has been removed and peritonealization of the ... begun. (Rankin.)

FIRST STAGE

Step 1. Incision over the tumor and abdominal exploration (Fig. 1864).

Step 2. Mobilization of the tumor (Fig. 1865).

Step 3. Ligation of the blood supply and dissection of the lymph nodes.

Step 4. Resection of the tumor with the cautery between clamps (Fig. 1866).

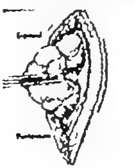


Fig. 1868

Fig. 1869

Fig. 1868. The peritoneum is brought under the loop and is sutured snugly around ... all sides. This step holds serous surface to serous surface, ... (Rankin.)

Fig. 1869. Second stage. After the clamp has been removed and the wound ... the spur ... cut out of the way ... by the application of clamps which remains through ... This step ... similar to that of the Block-Paul-Mikulicz operation. Courtesy of Dr. Fred W. Rankin.

Step 5. Peritonealization and closure of the rent in the mesentery (Figs. 1867-1868).

Step 6. Closure of the abdominal wound around the tumor.

SECOND STAGE

Step 1. Cutting of the spur (Fig. 1869).

Step 2. Closure of the colostomy (Fig. 1870).

Rankin uses a 3-bladed clamp for maintaining the segments of bowel. The blood supply to the loop is ascertained under direct vision. After the first clamps are in place another clamp is applied to them and divide the segments of bowel between these clamps with the thermocautery. The opening in the mesentery is closed. The raw surfaces on the sides of the resected bowel can be peritonealized with facility. Bring the clamp out of the wound in a position where least tension results on the structures. Close the wound snugly close to the clamp and pull a tongue of peritoneum in between the two limbs of the bowel under the clamp; this procedure brings the peritoneum snugly about

Fig. 1870. Final stage of the operation showing closure of the colostomy ... (Rankin.)

the bowel and renders the introduction of suture unnecessary except where the loop has been short and could not readily be delivered from the abdomen. Rankin wraps a piece of iodoform gauze around the clamp in the peritoneal cavity and then closes the peritoneum snugly around it in order to avoid contamination, in case of leakage.

After completing the operation, the wound having been closed tightly around the clamp, the bowel is left completely obstructed for from 60 to 72 hours. Rankin has never experienced any untoward results from this one step and neither was he ever compelled to remove the clamp sooner than 60 hours following the operation. No food is given by mouth and nausea or vomiting does not occur. Hypodermoclysis and intravenous administration of glucose and salt solution are resorted to.

At the time thought proper the proximal blade of the clamp is opened, the distal clamp is left closed and the clamp is not removed. This is desirable for agglutination has already taken place, the bowel has become sealed to the wound and if gaseous distention is sufficiently pronounced it will "blow out" the proximal end of the loop subjected to the pressure of the closed clamp and the bowel will relieve itself spontaneously. Rankin prefers this to opening the colon. The clamp is permitted to remain on the distal loop until it drops off (usually about the seventh day).

The further steps of the operation are those of the Block-Paul-Mikulicz procedure (p. 1456: removal of the spur with the enterotome or clamps). At least ... month should elapse before the final step (closure of the colostomy opening) is undertaken. If the spur is removed properly the opening will close spontaneously and the third stage of the operation will not be necessary.

In all nonobstructing mobilizable tumors of the bowel this procedure is the method of choice. With this operation, removal of the affected node-bearing area is made possible, ... conditions are obtainable as the classical Block-Paul-Mikulicz procedure which permits only ... local removal of the growth.

While in selected cases it would seem desirable to do an end-to-end anastomosis, with an enterostomy for decompression, at once, experience has shown that the mortality would be increased by so doing, or as Rankin puts it. It is hoped that in the future, with adequate pre-operative management and proper selection of cases, aseptic anastomosis at one stage, with or without proximal decompression, will become the operation of choice in ... high percentage of cases of malignancy of the colon. For the present, it appears certain that the graded procedure gives satisfactory results with lower mortality.

In ... recent communication Rankin wrote me: "I have frequently put de Pezzer catheter into the cecum at the same time as I was doing an obstructive resection in spite of the fact that the large bowel was effectually decompressed. This is ... very useful thing, especially in debilitated people and patients needing the patient cancer. It is ... good step, but I do not believe in using it routinely."

Rankin's Technic of Total Colectomy

According to Fred W. Rankin[1] two procedures are available in colectomy, viz.

(A) Three-stage operation consisting of:

[1] Annals of Surgery, 1931.

1. Ileostomy
2. Colectomy including the colon down to the rectosigmoid junction and
3. Combined abdominoperineal resection of the rectum.

(B) Proctosigmoidectomy followed by colectomy. If this method be adopted, the rectum and sigmoid left behind carry polyps which require electrosurgical or other means for their destruction. To counterbalance this, it has the advantage of (1) retaining the sphincteric apparatus and (2) avoiding the necessity of forming an artificial anus.

Nevertheless, the removal of the rectum at ... subsequent stage may become necessary to get rid of the polyps in the terminal segment of the bowel. And while one vacillates between the choice of the two operations Rankin sensibly ... that "after ileostomy and colectomy, if it is possible to get rid of the rectal polyps, ... sensible step is to implant the ileum into the top of the rectum at a subsequent operation."

From ... physiologic point of view we must remember that dehydration of fluid in ... serious undertaking—disturbed water balance follows it. As is known, the right portion of the colon absorbs most of the fluids taken. Ileostomy deprives the colon of its accustomed physiologic function and the loss of fluid is so precipitous that the patient loses weight and suffers from dehydration until the physiologic equilibrium is reestablished. When the patient begins to travel upgrade again the ileum gradually compensates for the right colon and assumes its function. Finally the stools become semisolid or formed. A colleague operated on by Rankin in the manner outlined observed the phenomenal physiologic readjustment described. He feels after ... earlier strenuous practice despite the loss of his colon and his ileostomy which made life ... burden to him.

Fig. 1871. Technic of Ileostomy. (Rankin.)

FIRST STAGE

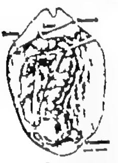
Ileostomy (Fig. 1871). This is of the single-barreled type. No double-barreled (loop) ileostomy is used. Rankin divides the ileum close to the ileocecal valve, turns the distal end in and brings the proximal end out through a McBurney incision, leaving ... clamp on it. The ileum is sutured very closely to the peritoneum. Close the wound snugly around it. Leave the bowel obstructed for about forty-eight hours, then remove the clamp. As one of the steps, Rankin says, "I have shut off the space between the mesentery of the terminal portion of the ileum and the lateral parietal peritoneum, just as one would do in performing colostomy involving the sigmoid. This prevents obstruction by loops of small bowel slipping around the structures formed at the ileostomy and becoming adherent once the ileostomy is formed through ... small McBurney

incision, in short, exploration, and the wound heals tight [illegible] single-barreled [illegible] results, which is not difficult to care for (Fig. [illegible]).

SECOND STAGE

Three weeks are permitted to elapse before the second stage in the operation is undertaken. Physiologic readjustment takes place during that period. The patient is brought to the optimum condition for the strenuous ordeal of colectomy. The colon is removed through [illegible] left rectus incision. The dissection begins at the cecum on the right side of the colon. Mobilize the bowel by dividing the outer leaf of the peritoneum (Fig. [illegible]). Ligate and divide the blood vessels close to the bowel. Leave sufficient peritoneum to cover the resulting raw surfaces. Avoid injury to the ureter and retroperitoneal portion of the duodenum. Having mobilized the right section of the colon and ligated the vessels securely, the raw surfaces of the remaining mesentery (Fig. [illegible]) are

Fig. [illegible]. [illegible] (Courtesy of Dr. Fred W. Rankin.)



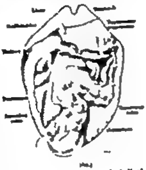


Fig. 2643 Fig. 2644

Fig. 2643. Total colectomy. Beginning mobilization of cecum and right half of colon. [illegible]

Fig. 2644. Further mobilization of the right portion of the colon and of the transverse colon. The omentum has been divided. (Rankin.)

carefully sutured. Mobilize the transverse colon up to the splenic flexure. Mobilization of the latter is the most difficult step of the operation. Its position

is usually higher and fixed; these drawbacks are overcome by dividing the splenocolic ligament; clamp, ligate and divide the blood vessels. Proceed with the mobilization of the descending colon and sigmoid flexure (Fig. [illegible]).

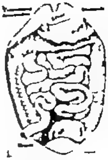


Fig. 2645 Fig. 2646

Fig. 2645. Mobilization of the colon has been carried down to the junction of the descending colon with the sigmoid. (Rankin.)

Fig. 2646. Total colectomy completed. The raw surfaces left by dissection are closed with running sutures. A new pelvic floor has been made out of peritoneum. (Rankin.)

As on the right side, the left parietal leaf of peritoneum is divided, the colon and sigmoid loosened, the blood vessels clamped, ligated and divided and the raw surfaces peritonealized. Rankin thinks it wiser to divide the bowel at about the middle of the sigmoid or at the juncture of the lower and middle thirds of the sigmoid in order to insure adequate vascularization of the portion of the bowel left behind (Fig. 2646).

In operating for polyposis, [illegible] point with good blood supply is selected. The bowel is divided with the electrocautery between two clamps and the lower end is turned in. In ulcerative colitis [illegible] is impossible to turn in the lower end with [illegible] suture. Rankin divides the bowel, holding the lower end very tightly and then sutures over and over, without attempting to turn it in, wrapping it in iodoform gauze and bringing it out through the lower end of the wound. Drainage is thus instituted. Peritonitis is rare except in the congenital type of polyposis. Total colectomy is completed as shown in Fig. 2646.

THIRD STAGE

Usually two or three months are permitted to elapse before this stage of the operation is undertaken. In complicated cases this stage is the most difficult one to perform and is performed according to Rankin's abdominoperineal resection of the rectum (which see).

Aseptic End-to-Side Ileocolostomy: Clamp Method

RANKIN'S TECHNIC

According to Rankin, end-to-side anastomosis between the terminal ileum and the transverse colon is decidedly the most satisfactory method in cases where it is desired to resect the right half of the colon either immediately or subsequently. The greatest advantage of end-to-side anastomosis is the ability thereby to side-track the fecal current from passing over an ulcerating surface. Rankin and A. Stephens Graham believe that "the mortality of [illegible] graded operation is largely dependent upon the amount of infection around the primary growth which not only renders immediate resection hazardous but greatly undermines the individual's powers of resistance. Reduction of this infection and rehabilitation are two steps which are not to be gainsaid in [illegible] successful attack on right colonic lesions. Moreover, the end-to-side anastomosis more closely approaches the natural anatomic relationship of ileum to cecum." Rankin and Graham describe the operation as follows:

"If one can determine in advance that the contemplated resection will not be attempted at the initial operation, there is an advantage in making [illegible] left rectus incision which centers on the umbilicus. This permits subsequent entrance into the abdominal cavity through [illegible] right rectus incision, unhampered by possible infection of the primary wound. Otherwise [illegible] right rectus incision is made in the first instance. The liver and aortic glands are first palpated to determine the presence or absence of gross metastatic implants, and finally the growth and the lymphatics adjacent to the outstanding portion of the bowel are visualized [illegible] possible, then palpated. The latter maneuver should be conducted with considerable circumspection and great gentleness. Theodor Kocher [illegible] for many [illegible] iodoform [illegible] very very easily and unexpectedly [illegible] finger into an abscess should it be present. Moreover the spread of infection from the primary growth throughout the peritoneal cavity by the examining hand because of the number and virulence of the organisms in and about the growth is an easily demonstrated danger.

"The terminal portion of the ileum about ten to fifteen centimeters from the ileocecal valve is brought into the wound. Ordinarily it will be found necessary to tie but [illegible] few of the terminal branches of the mesenteric vessels just before they enter the intestinal wall. By avoiding the larger vascular branches and, therefore, disturbance to the circulation of the bowel, the technic is simplified and time is saved in that the necessity for removing [illegible] segment of bowel is eliminated. In order to secure as large an opening in the intestine as is possible the special clamp is applied to the ileum at about an angle of 45° (Fig. [illegible]). A Payr or any other suitable clamp, is applied distal to the first and as close to it as is possible and the bowel between them is divided with [illegible] cautery; the end toward the cecum is invaginated and dropped back into the abdomen, to be removed with the colon at subsequent resection. A point is now selected on the anterior surface of the transverse colon, ordinarily at about the junction of the proximal and middle thirds unless the growth is at the hepatic flexure, in which case

more distal point is chosen (Fig. [illegible]). Allis forceps then are applied to the colon sufficiently far apart to assure an opening comparable in size to the diameter of the ileum and with these forceps elevated the selected segment of colon is fixed by the free blade of the special clamp, one blade of which already contains

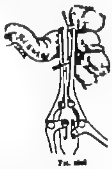


Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Application of clamp to ileum. The blood supply in the mesentery has been [illegible] and the special clamp [illegible] applied [illegible] an angle so as to [illegible] under forceps for the anastomosis. The bowel [illegible] divided with cautery. (Rankin.)

Fig. [illegible]. The clamp [illegible] shown being applied to [illegible] point selected on the transverse colon for the anterior wall of the anastomosis. (Rankin.)

the proximal portion of ileum. The elliptical piece of colon which protrudes above the closed blade of the clamp is removed with the cautery leaving the cauterized edges of the two pieces of bowel occupying positions exactly opposite each other (Fig. [illegible]).

"The clamp and the mobility of the bowel permit easy manipulation in establishing the anastomosis. The clamp is now turned completely over making the handle point away from the operator so as to bring the posterior side of the bowel into view (Fig. [illegible]). This permits accurate approximation of the peritoneal coats of the bowel on the undersurface of the anastomosis, because here the two arms of the bowel are in juxtaposition. A continuous suture (our preference is chromic catgut to which [illegible] curved needle is welded) is employed and it is tied at one end and locked at the other; the two ends are left long in order that the ends of the anterior suture may be tied to them after removal of the clamp. The clamp [illegible] now turned back to its original position and starting with [illegible] new suture (this should be an invariable rule) the anterior line of suture is applied by means of [illegible] continuous Cushing stitch which passes over the upper surface of the clamp; ties are not made at either end at this stage since to do so would defeat the purpose of this inverting type of suture (Fig. [illegible]). Preparations are now made for removing the clamp. An assistant grasps one of the long ends of the posterior suture in order to steady the bowel, and as the operator withdraws the clamp, the blades of which have been opened slightly, the assistant

draws his end of the anterior suture taut, thus commencing the process of inversion. When the clamp has been completely withdrawn, the operator draws his end of the anterior suture taut and in this manner completes the inversion.

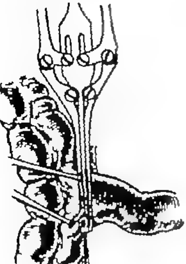


FIG. [illegible]. An [illegible] portion of the colon [illegible] being removed by [illegible] to make an opening [illegible], the small bowel [illegible] shown approximated at this point. (Rankin.)

The agglutination of the two ends of the bowel under the steady pressure keeps it intact as this maneuver is carried out. Leakage at this stage has not occurred in any of our cases. The two ends of the anterior suture are now tied with the corresponding end of the posterior suture. Another layer of sutures, either continuous or interrupted, is inserted around the entire anastomosis and tags of fat and omentum are attached at both ends as a precaution against leakage. At this stage it is well to force the wall of the colon ahead of the fingers until the fingers are felt to have passed through the anastomosis, thus to break out the agglutination which forms a diaphragm (Fig. [illegible]).

Although we did not establish an enterostomy proximal to the anastomosis in any of our [illegible] cases, we are cognizant of its potential value under certain circumstances and believe that thorough consideration should be given to its employment in every case. Pringle believes that death in acute septic peritonitis is due to intestinal toxemia secondary to paresis of the inflamed intestine rather

than to absorption of the products of the suppurative inflammation of the peritoneum. Handley and others concur in this opinion. If this [illegible] true then [illegible]

FIG. [illegible]

FIG. [illegible]

FIG. [illegible]. Ileocolostomy over [illegible] clamp. Posterior layer of sutures approximating the ileum and transverse colon. Clamp [illegible] turned over. (Rankin.)
FIG. [illegible]. Ileocolostomy over [illegible] clamp. Anterior layer of sutures applied. [illegible] Posterior suture [illegible] anterior suture [illegible] shown, the operation completed. (Rankin.)

[illegible] established at the time of operation should prove a sound precautionary measure as regards the probable development of peritonitis. Moreover, enterostomy possesses the very desirable feature of lessening intra-intestinal pressure which might produce undue tension on the line of sutures.

"The abdominal wound is closed in the usual manner and without drainage. We consider it important in these cases always to insert a rectal tube or rectal tube which is left in place, except for cleansing, during the first seventy-two hours in order to prevent an increase in the intracolonic pressure.

FIG. [illegible]. The fingers are [illegible] through the anastomosis to break up the [illegible] which forms a diaphragm. (Rankin.)

"The details of the preoperative and postoperative care of such cases have recently been outlined by Rankin, Bargen and Buie and unquestionably are highly important to comfortable convalescence."

Summary. (1) In cases of carcinoma of the right half of the colon, it is our feeling that aseptic ileocolostomy between the terminal ileum and the transverse colon followed by resection of the right segment at the same stage or a subsequent one is the procedure of choice.

([illegible]) The employment of end-to-side anastomosis rather than lateral anastomosis is urged in this particular instance because of the very desirable feature

which the end-to-side method has over the lateral in obstructing the fecal current and allowing as much reduction of local inflammatory reaction around the growth as is possible. Moreover the end-to-side anastomosis more nearly approaches the natural anatomical relationship of ileum to cecum.

Colectomy

The removal of segments of the large bowel presents difficulties not encountered in dealing with resections of the small intestine. Anatomic peculiarities with reference to fixation, location, and blood- and lymph-vessel distribution of the particular segment of bowel coming under consideration are all factors playing an important rôle in resections of this part of the intestinal tract.

Fixation, rendering the operation difficult, may be overcome by dividing the parietal peritoneum at the outer border of the bowel thus rendering a fixed part of the intestine mobile.

Devine's Methods in Surgery of the Colon

Sir Hugh B. Devine points out[*] that the operative mortality rate for carcinoma of the colon is [illegible] to [illegible] per cent according to the figures.

	OPERATIVE MORTALITY PER CENT
Miller	[illegible]
[illegible] taken from [illegible] hospital records ([illegible])	
Distal colon carcinoma	[illegible]
Proximal colon carcinoma	[illegible]
[illegible] (Mayo Clinic)	
Resections for growths in left side of colon with clamp and exteriorization	
Rankin	[illegible]
Clements	[illegible]
[illegible] and [illegible]	
Distal colon carcinoma	
Proximal colon carcinoma	[illegible]

Recent advances in the treatment of carcinoma of the colon with the aim of lowering this rate are:

1. Early diagnosis.
2. Increasing patient's general resistance.
3. Preoperative drainage of colonic contents.
4. Removal of distal colon carcinoma by modification by Bloch-Paul[?] method.
5. Devine's method of "defunctioning" of the colon.
6. Devine's "Exteriorization method" for bad cases of proximal colon carcinoma.

The choice of anesthesia contributes greatly to the safety of operative procedures on the colon. Ether anesthesia is contra-indicated in many of these cases. Spinal anesthesia cramps the freedom of the surgeon to operate quickly and the healing of wounds is not as satisfactory. The most satisfactory method of anesthesia for these cases is nitrous oxide and oxygen, with addition of a little ether where relaxation is needed.

Preoperative drainage of the colon in treatment of carcinoma of the distal colon is done with a view of removing the evil effects of intestinal obstruction and

* Med. Press and Circ., Aug. [illegible], Vol. CXC, No. [illegible]

of bringing the contents of the colon and the condition of its walls back to normal.

The method of colonic drainage is important. A fistulous opening at a distance from the obstruction will not drain the colon completely; and an opening close to the growth makes the resection difficult and fecal discharge soils the operative area.

An anus with a spur drains the bowel satisfactorily—but in a malignant segment, there is not sufficient bowel available for its construction.

The difficulties and dangers of using a colostomy [illegible] in the distal colon are:

1. Sinking of the [illegible]—with occurrence of peritonitis.
2. Poor vascularity for proper repair.
3. Peritoneal union of colon—may leak.
4. High mortality rate.

Modification of Bloch-Paul's method is to convert a three-stage operation into a one-stage operation.

Modification

Step [illegible]. After the resection of the segment of the bowel containing the growth, the cut ends of the proximal and distal segments of the colon are allowed to project a short distance above the abdominal surface.

Step [illegible]. An enterotome shaped to encourage peritoneal adhesion along the line of the anastomotic opening about to be produced, is at once applied, and the divided ends, after a cuff of the peritoneum and muscular coat of the bowel is turned back, are closed down over the enterotome, except for the necessary drainage.

Note. This type of operation requires sufficient mobile bowel. It is applicable only to growths in the middle portion of the sigmoid or transverse colon.

Devine's Method of Colonic Resection

(Study Fig. [illegible] A (p. 1410) in conjunction with text.)

Indications. Operations in the distal colon where Bloch-Paul's principle is inapplicable, such as the upper or lower parts of the sigmoid, the rectosigmoid junction, the splenic flexure, or the descending colon.

Rationale. This method is based on the principle that if a segment of bowel be isolated and then deprived of its function, its bacterial count will slowly disappear. Fecal content is absent. The walls become thicker and more vascular and the segment is free from peristaltic movements.

Stage I

"Defunctioning" the Distal Colon. Disconnect the proximal from the distal colon by an artificial anus either at the middle of the transverse colon or the hepatic flexure.

Step 1. Make an incision two and a half inches long in the upper right rectus muscle. Explore thoroughly.

Step 2. Bring out the proximal part of the transverse colon. Pass a rubber tube through the spur of the loop; connect the limbs with a running suture making a spur four or five inches long. If the transverse colon is too short, suture its proximal part to the ascending colon (Fig. [illegible] A).

Step 3. Suture the parietal peritoneum around the neck of the loop (Fig. 1643 b).

Step 4. Make button-hole openings, through skin and fat only, on each side of the incision. Through these grasp with Kocher clamps the loop of bowel and divide it with a diathermy knife (Fig. 1643 b).

Step 5. Pull the bowel ends through the small incisions and suture them to the skin edges. Close the exploratory incision (Fig. 1643 c, d).

Step 6. Remove the proximal Kocher clamp in twelve hours; the distal clamp is left on several days.

Preparation of the excluded distal colon. Lavage the distal colon either by rectum or the abdominal fistula with antiseptic solution, or instill cod liver oil (Fig. 1643 e). A period of about three weeks is necessary for the colon to be reasonably clean, before resection can be carried out.

Stage II

A month later perform an anastomosis in the "defunctioned" distal colon (rectosigmoid tumors) by resecting the tumor and suturing the divided end of the sigmoid to the rectum, or do a telescopic anastomosis.

Resect the tumor. Suture the severed rectum. Close the peritoneum over it. Implant the divided end of sigmoid in the wound.

Six months later

Step 1. Reopen the abdomen by a median subumbilical incision.

Step 2. Make an incision around the artificial anus so that a substantial ring of skin is left attached to the mucous membrane. The sigmoid loop is disconnected from the abdominal wall, and the descending colon is mobilized.

Step 3. Suture a rubber tube to the ring of skin which has been left attached to the detached end of the colon.

Step 4. Introduce a sponge holder with a swab on the end through the anus into the rectum and have an assistant press it against the upper blind end. Make an incision from above of appropriate size through the rectal wall on to the swab. The forceps is now made to grip the end of the tube and is drawn, with the attached bowel, through into the rectum.

Step 5. The sphincter is dilated and the tube so fixed as to keep the parts in fixed position. By the time the rectosigmoid junction is complete the sphincter has healed. In order to insure the patient continence [illegible]

Stage III

Closure of the Disconnecting Anus

Step 1. Crush the spur for 48 hours with the Devine enterotome. Five or six days later inject some antiseptic solution around the bowel openings (Fig. 1643 f).

Step 2. Divide the segment of skin between the two openings of the bowel, which should be mobilized, and close by a few sutures.

Closure is usually prompt.

Operations for Proximal Colon Carcinoma

Hemicolectomy by the Devine Exteriorization Method

Step 1. Make a midline incision. Mobilize the terminal ileum, the cecum, the ascending colon and the hepatic flexure, and bring them to the surface.

Step 2. Divide the vascular connections of the mesenteric leaf.

Step 3. Make a long spur by suturing for four inches a segment of the ileum to the transverse colon.

Step 4. Exteriorize the terminal ileum, the proximal colon and the separated mesenteric leaf.

Step 5. Close the peritoneum and suture it carefully around the limbs of the ileum and colon as they emerge from the abdominal wall.

Step 6. Close the layers of the abdominal wall.

Step 7. Now remove the carcinoma leaving the ends of the ileum and of the colon protruding for about an inch beyond the abdominal wall.

Step 8. Apply a Devine enterotome to the spur between the ileum and the transverse colon. Close the cut end of the colon by interrupted sutures around the enterotome.

Step 9. Remove the enterotome in forty-eight hours, leaving a small colonic opening, as well as a small ileal opening which acts as a safety valve to drain the obstructed bowel.

SHORT-CIRCUITING OPERATIONS

INTESTINAL EXCLUSION

Von Hacker set down clinical indications for the performance of intestinal exclusion in 1891 while Salzer popularized the method in 1891 and 1892. The distinction of performing the first short-circuiting operation on man belongs to Trendelenburg. The intestinal exclusion was done in 1885.

Indications for Exclusion

Intestinal ulcerations causing fistulas.

Intestinovaginal fistula following hysterectomy.

3. Chronic intussusception.

4. Certain forms of colitis (ileosigmoidostomy).

5. Carcinoma of the cecum and ascending colon when resection is contraindicated.

Forms of Intestinal Exclusion

Partial exclusion.

Entero-anastomosis (Maisonneuve's operation).

Entero-anastomosis with constriction by suture of the part distal to the upper opening.

Complete exclusion.

Unilateral Exclusion (Nicholas Senn's Operation). The bowel is divided and the proximal end is anastomosed with the side of the distal end, or the distal end may be closed or left open. Only healthy sections of bowel should be anastomosed. Never suture distended or dilated intestines.

Unilateral exclusion with termino-lateral (ileotransversostomy) anastomosis with or without colostomy may be resorted to.

An ileosigmoidostomy may be done with implantation of the distal end of the ileum into the abdominal wall.

In unilateral exclusion, there persists more or less tendency for intestinal contents or gas to enter the excluded segment via the established anastomosis.

Bilateral exclusion with closure of both ends of the excluded segment of

bowel is of historical interest only. It was advocated by Obalinsky and partly condemned by Mayo Robson.

Perforation of the segment of bowel excluded at both ends and remaining in the abdomen may take place as late as 15 years after operation, as in the case of Wiesinger. Besides, the collection of intestinal secretions and of products of ulceration of the wall of the excluded segment or [illegible], which the excluded bowel represents, may give rise to severe auto-intoxication.

A number of methods have been devised to obviate these drawbacks, viz.

Kocher's Method. This consists of

a. performing a unilateral exclusion with

b. implantation of the proximal end of the excluded segment into the colon beyond the point of the established anastomosis.

Bringing up the distal end of the excluded segment into the abdominal wall.

3. As in 2, with the addition of a cecostomy.

Hochenegg's Method. In this operation the two open ends of the excluded segment are brought to the surface of the abdominal wall and sutured there.

6. Salzer's Operation. The bowel is divided in two places. Do an enteroanastomosis. A segment of bowel is left detached. One opening is closed, the other is brought to the surface to form a fistula, or both ends are attached to the skin.

INOPERABLE TUMORS

In this class of cases an exclusion operation (entero-anastomosis) or an ileosigmoidostomy is at the surgeon's command to afford the patient, if not lasting, at least, temporary relief for a greater or lesser period of time. The former is preferable, more comfortable to the patient and should be practiced when an [illegible] exists.

OPERATIVE PROCEDURES IN ACUTE INTESTINAL OBSTRUCTION

The first important factor to remember is: as soon as obstruction is diagnosed the patient should be operated on without delay (Figs. 1644, 1645, 1646). Procrastination often spells death.

Spinal. Wherever possible spinal anesthesia is the ideal form of anesthesia. I do not use subarachnoid block in cases where the systolic pressure is below 100. Spinal anesthesia will often permit a distinction between spastic and mechanical ileus.

The incision. If a definite diagnosis is made the incision is placed over the seat of the trouble. If in doubt, an ample median or paramedian exploratory is carried out. The seat of the obstruction is ascertained by either of the following procedures.

Palpation and inspection.

Finding the junction of the collapsed and distended segments of bowel.

3. Evisceration.

If the large bowel is distended the seat of the obstruction is in the large intestine; if collapsed, in the small bowel.

Fluoroscopy is of inestimable value in making a diagnosis. If the small

bowel is markedly distended and interferes with the operative manipulations, an enterostomy should be promptly performed (see above).

Fig. 1644.

Fig. 1645.

Fig. 1644. Intestinal obstruction. The flat plate of the abdomen showing gas filled bowel with "ladder" or step-ladder formations especially well seen on the left side. [illegible] (Roentgenologic [illegible], Cook County Hospital.)

Fig. 1645. Intestinal obstruction. [illegible] (Roentgenologic [illegible], Cook County Hospital.)

Fig. 1646. Intestinal obstruction. [illegible] "herring bone" appearance of [illegible] the patient.

Fig. 1647. Large bowel [illegible] of the [illegible].

In order to avoid intestinal contents entering the stomach during exploration von Eiselsberg recommends to apply a Doyen intestinal clamp to a loop of

jejunum high up into the stomach. This effectually prevents regurgitation of intestinal contents. This accomplished, systematic exploration of the large bowel may proceed.

If the trouble be in the small intestine the sites of predilection (hernial apertures, etc.) are at once sought. A collapsed segment of bowel is sought and

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Intestinal obstruction the result of lodgment of large gallstone. Female patient, aged [illegible] years. Stone removed by enterotomy. (Dr. Phil Thorek.)
Fig. [illegible] Gallstone causing intestinal obstruction.

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Openings in the mesentery may permit a loop of bowel to slip through and become strangulated and twisted. The mechanism is shown in this illustration.
Fig. [illegible] The loop shown in Fig. [illegible] has been reduced, detorsion has been done and the opening in the mesentery is ready to be closed.

followed to the point of obstruction. If this fails, exploration will have to be resorted to.

Obstructions may also be occasioned by:

Foreign bodies (gallstones [Figs. [illegible]], fecal impactions, worms, etc.)
2. Mesenteric thrombosis.

3. Volvulus.
4. Intussusception.
5. Strangulation by bands of adhesions or Meckel's diverticulum.
6. Internal hernia.
7. Holes in the mesentery, etc. (Figs. [illegible]).
8. Compression from without.
9. Tumors of the omentum.
10. Benign tumors of the intestinal wall.

Foreign bodies are removed by enterotomy (see p. [illegible]).
Early operation is imperative.

MESENTERIC THROMBOSIS AND EMBOLISM

This entity was first described by Virchow in [illegible]. Only in exceptional instances does collateral circulation take place in these cases, Cokkinis ([illegible]). The prognosis is grave. Prompt interference is essential.

When the transverse colon is involved by reason of blockage of the middle colic artery the treatment is obvious. Resection of the affected segment with end-to-end anastomosis should at once be done supplemented by [illegible] cecostomy.

If the Right Half of the Colon is Occluded. Resect the cecum and ascending colon. Ileocolostomy. If the left half of colon, resection or Mikulicz-Paul operation should be done. If the small intestine is affected, it, and the mesentery carrying the blocked and affected segment of bowel should be removed. Often it is imperative after resection has been performed to bring both limbs of the divided bowel out of the abdomen; they are placed side by side and their peritoneal surfaces sutured to the abdominal wound. It often is advantageous to insert [illegible] Paul tube into each opening. Thorough drainage is essential. After some time, depending on the factors pertaining to a given case the second stage of the operation is performed, which consists of the closure of the intestinal fistula by either an end-to-end or side-to-side anastomosis.

Only a few cases of this type on record have recovered. Resection, if done, must be very thorough.

VOLVULUS

This is a torsion of the bowel and its mesentery. There are three sites of predilection for volvulus:

1. The lower segment of the small bowel.
2. The cecum with a long ileocolic mesentery and
3. The sigmoid flexure.

Volvulus of the Small Bowel

1. Gain prompt access to the twisted bowel (enterostomy, if need be). Divide adhesions about the twisted bowel.
3. Detorsion of the affected segment (Fig. [illegible]) supplemented by plication of the mesentery in the same manner as shown in Fig. [illegible], p. [illegible].
4. After detorsion, ascertain the viability of the bowel (hot lap-packs). If viable, replace the affected segment of intestine into the abdomen; if not, do an enterectomy with anastomosis.

5. If the patient's condition is precarious it is better to do an enterostomy following detorsion.

Fig. [illegible] Proper method of untwisting a volvulus. Note detorsion [illegible] [illegible] [illegible] [illegible] [illegible] of the normal direction [illegible] [illegible].

Fig. [illegible] Reducing an intussusception. The left hand [illegible] the invaginated portion [illegible] [illegible] [illegible] [illegible] [illegible] of the invaginated bowel. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] with the right hand.

Volvulus of the cecum is treated by detorsion and fixation or plication of ileocolic mesentery (Fig. [illegible]).

Volvulus of the Sigmoid Flexure

Sigmoidoscopy. Endeavor to pass a rectal tube; if this fails

Open the abdomen through a left lower paramedian incision.
Deliver the volvulus.

1. Attempt detorsion. While so doing have an assistant manipulate a tube in the rectum with the object of passing the obstruction, as soon as detorsion is effected.

2. If the distention is so marked that attempts at detorsion become threatening evacuate the gas by puncturing (small trocar) the bowel through a [illegible]

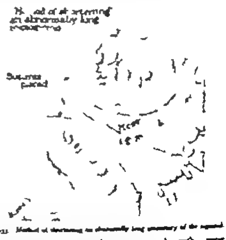


Fig. [illegible] Method of shortening an abnormally long mesentery of the sigmoid.

and permit the gas to escape. Close the puncture opening with a purse string suture. Do [illegible] sigmoidopexy.

3. If [illegible] is impossible to effect detorsion,

Sew a tube into the apex of the distended sigmoid loop until conditions are propitious for a resection.

In gangrene of the loop with the patient in good condition,

Do a resection, end anastomosis. Paul tube into each limb of the bowel. If the condition of the patient is bad, perform Mikulicz-Paul operation with tube introduced and do [illegible] resection later.

Volvulus of the sigmoid tends to recur. To avoid this, shortening and fixation of the mesentery has been advised by Nicholson [illegible] ([illegible]). If this fails resection should be done. (Fig. [illegible])

A case of volvulus and obstruction of the sigmoid caused by the [illegible] [illegible] was recently operated on [illegible] [illegible] by Dr. Phil Thorek. [illegible] Cook County Hospital.

Fig. 1632 Fig. 1633
Figs. 1632 and 1633. Diverticulosis of the large bowel ... showing ... diverticula ... inflammatory changes. Courtesy of ...

DIVERTICULOSIS AND DIVERTICULITIS

About 5 per cent of people over forty years of age have diverticulosis which consists of the formation of sacs along the line of entry of the blood vessels at the sides of the attachment of the mesentery. In some instances they affect the appendices epiploicae. However the sigmoid colon is the usual site of occurrence (Figs. 1632 1633). This condition does not produce symptoms unless the sacs become inflamed from irritation caused by the stagnation of their contents (diverticulitis). The condition often calls for surgical treatment. It may appear as so-called

Left-sided appendicitis—acute diverticulitis
2. Chronic diverticulitis with intestinal obstruction
3. Diverticulitis with perforation abscess formation and external fistula
4. Diverticulitis with internal fistula

According to Wakely there is no causal relationship between diverticulitis and malignancy. Lockhart Mummery also favors this view.

Treatment

Acute diverticulitis. Laparotomy excise the affected diverticulum and suture the colon. A decompression colostomy may be advisable in complicated cases.

Chronic diverticulitis with obstruction. Do laparotomy explore do cecostomy or transverse colostomy to 3 months later resect the affected sigmoid carrying the diverticula.

3. Abscess from perforation: drain the abscess. Later proceed as outlined above.

4. Internal fistulae: perform temporary colostomy. Later excise the fistula and repair the affected bowel.

INTUSSUSCEPTION

This condition usually occurs in children, the ratio being 95 children to every 5 adults and is usually caused by benign tumors (lipomas, polyps, ulcerations, etc.). (Fig. 1636.)

ACUTE INTUSSUSCEPTION IN INFANTS

General Anesthesia

Hamilton Bailey states: For some time I have used spinal anesthesia in these cases ... reserving general anesthesia for special cases, such as older children in good condition, or ... the services of a specially skilled anesthetist are available. The advantages of spinal anesthesia outweigh its disadvantages when operating upon the average case under ordinary emergency conditions.

Bailey uses ... cc. in saline solution as ... standard dose up to the age of two years, after which the dose may be increased. He advises against ... and administers ½ cc. of pituitrin to counteract the fall of blood pressure.

OPERATION

Step ... Open the abdomen through ... right paramedian incision extending above and below the umbilicus.

Step 2. Explore gently and identify the invaginated segment of bowel. Bring out of the abdomen. Pack the rest of the abdominal cavity off with lap packs of proper temperature. Use every means to retain the body temperature of the patient.

If the mass of bowel involved in the process cannot be delivered, ... to disengage the intussusception with the bowel in situ.

Step 3. Disengagement should be done by gentle manipulations only. Do not use force. Squeezing at one end ... will often suffice.

While Hamilton Bailey justly says, "push but never pull," nevertheless, gentle guidance of the intussuscepted bowel, while pressure is carried on the tumor mass, has turned out ... experts.

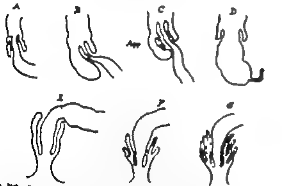


Fig. 1636 Diagrammatic sketch showing types ... intussusception. A, Ileo-ileal. ... Ileo-colic. C, Cecocolic, ... Colic, E, Retrograde ... Double, G, Triple, ...

Step 4. After disengagement, make sure that the bowel is viable. If so, replace the disengaged intestine into the abdomen.

Step 5. Close the abdominal wound in layers.

Step 6. The removal of sutures should not be hurried. Follow the advice of Robbins. It is advisable to leave sutures in for 12 to 14 days or even longer if eventration are to be avoided. Do not attempt to avoid recurrence by some form of plication or suspension. Any such devices to shorten the mesentery or anchor the cecum, Childe justly remarks, are examples of misdirected surgical zeal. Yet, Sorrowsend, Fournier and Chelsham recorded successes after performing cecopexy supplemented by appendicectomy in intussusception cases.

What T... Do If the Intussusception Is Irreducible

The following methods are at our disposal

Cope's Method (Fig. 1637 a). This consists of imbricating the little finger

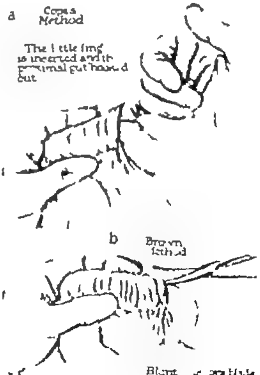


Fig. 1637

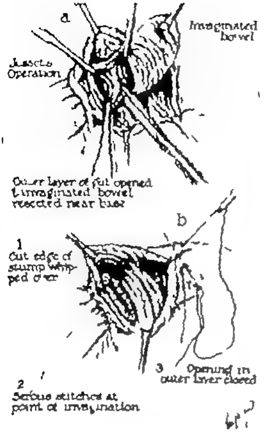


Fig. [illegible]

between the intussusceptum and intussuscipiens and separating the one from the other followed by desinvagination.

Dowd Method. Here, instead of the index finger, a stick sponge or some blunt nosed forceps is used for separating (gently) the involved portions of bowel.

Brown Method (Fig. [illegible] b). One blade of a pair of Mayo scissors is introduced through the constricting ring of bowel which is divided. After reduction, the incision is sutured.

Hipsley Preliminary Injection Treatment of Intussusception

P. L. Hipsley* points out the value of preliminary injections of salt solution into the rectum, stating that about [illegible] per cent of all cases will be completely reduced, that doubtful cases show at least [illegible] per cent reduction and that there are still others that would in all likelihood be reduced by a more prolonged effort. Since pressure at the apex of the intussusception effects reduction, it does not matter whether such pressure is digital or hydrostatic. Rupture of the bowel from hydrostatic pressure may be ignored. A column of water 3 feet 6 inches in height, which equals a column of mercury [illegible] mm., is quite safe. Palpation of the abdomen during hydrostatic reduction is dangerous. Hipsley states that he used this method as a routine for over twenty years and he has not made a single mistake as to the completeness of the reduction.

The quantity of the salt solution varies with the age of the child. It is not the quantity but the pressure of the solution which is the important factor. General anesthesia is used and the surgeon must be in readiness to operate should occasion arise. No higher pressure than indicated above should be resorted to. Use an ordinary glass douche container so that the level of the water may be seen. Suspend the vessel so that the height of the column of solution is 3 feet 6 inches above the table on which the child lies. Insert a No. [illegible] soft rubber catheter a few inches into the rectum. Push the buttocks together. No lubricant is used. After 5 minutes disconnect the catheter; allow the saline solution to escape into the bedpan. Repeat this twice at three minute intervals. On occasion Hipsley prolonged the solution to contain it in an [illegible].

Signs of complete reduction. (1) Obvious distention of small bowel following injection. (2) Alteration in the circumference of the abdomen (increase of about [illegible] inches around the umbilicus when reduction has been effected); (3) Yellow fecal matter is often seen in the third return of saline; (4) Passage of flatus. (5) X-ray appearances after opaque injection. (6) Charcoal through stomach tube will be recovered 3 hours later in large bowel washings.

Operation should be undertaken when evidence points that reduction is incomplete. Results depend upon early diagnosis and adequate treatment. Combat shock, restore loss of fluids and chlorides. When forced to operate Hipsley favors lateral anastomosis leaving the unreduced portion of bowel in situ.

When All of these Methods Fail

Resect the affected segment of intestine, followed by an anastomosis (side-to-side). Resection is to be [illegible] last resort because the mortality is tremendously high in young infants ([illegible] per cent).

Intussusception in Adults

After desinvagination, a tumor is usually found to be responsible for the intussusception. Such tumor must, unreservedly be removed. If left behind, a recurrence of the invagination is sure to follow soon.

Surgery, Vol. [illegible] No. [illegible] Jan., [illegible] p. [illegible]

In adults, resection is the method of choice. If the small intestine is the seat of the intussusception and if the patient's condition is good, a one-stage operation is performed. In the large intestine graded operations are preferable.

In some cases of irreducible intussusception without gangrene, a short-circuiting operation may be performed with success (P. [illegible]).

If the bowel is irreducible and gangrenous, the following methods are at our command:

Resection with end-to-end or side-to-side anastomosis.

Jesset's operation (Fig. [illegible]). This consists of removing the invaginated portion of bowel alone, through the ensheathing portion of the intestine.

After the incision in the bowel is made, the invaginated part is pulled as far downward as possible and is cut away. A circular suture unites the divided edges of the amputated, gangrenous bowel. The ensheathing portion of the bowel is now closed by a continuous suture (through-and-through) superimposed by a Lembert stitch. A few interrupted sutures are placed at the neck of the intussusception.

OBSTRUCTION OWING TO BANDS AND ADHESIONS

Prompt division of the constricting band is followed by immediate relief. The earlier, therefore, the diagnosis is made and the earlier the treatment, the better is the prognosis.

Intraperitoneal adhesions may produce acute and chronic obstructions.

Guides

If the history and symptoms point to a certain region, explore that section.

If in doubt as to where the obstruction exists, explore the pelvis first. Search for a collapsed portion of bowel. When that is found follow it to the point of obstruction.

3. If the cecum and colon are distended explore the rest of the large bowel, notably the sigmoid flexure.

How to Deal with Adhesions

If cordlike, divide them between two artery forceps, ligate the ends and remove the redundant part. Flat, recent adhesions may be separated by gentle pressure with gauze wrapped about the index finger.

Old adhesions. Be moderate in the extent of separation. Divide only those adhesions that are directly concerned in the obstruction. Gentle separation with scalpel and scissors with particular attention to avoid injury to the bowel should be the guiding rule. Cover raw surfaces (suture, free omental graft, etc.) wherever possible.

When the bowel is greatly distended, we may be compelled to do an enterostomy to enable thorough work to progress. Multiple adhesions may present too formidable a task for successful separation (tuberculous peritonitis, etc.). Lateral entero-anastomosis or more than one of such intercommunications may be necessary to accomplish the desired end.

In order to avoid recurrence, the constricting band should, whenever possible

be excised. These bands are often vascular. Proper hemostasis should be looked after.

Where the strangulation has lasted a long time and gangrene of the affected segment of bowel is encountered, resection with proper anastomosis is the best cure.

Exteriorization (Bloch-Paul-Mikulicz Operation) does not serve as well in the care of the small intestine as in affections of the large bowel where it constitutes the procedure of choice.

A history of previous operation often aids in the diagnosis of intestinal obstruction.

INTESTINAL OBSTRUCTION FOLLOWING APPENDICECTOMY

While the patient is still under treatment. In these cases symptoms of obstruction usually become manifest within the first fortnight after appendicectomy. Hamilton Bailey recognizes three different types of this category of affections, each of which requires different therapeutic measures.

Type I

This occurs within the first ten days following appendicectomy. Here, procrastination spells death. Upon the very first symptoms of obstruction, the abdomen should be opened and the obstruction, usually fresh adhesions from coils of intestines to some raw surfaces, should be promptly relieved. In these cases, mild symptoms are often misleading and should put the surgeon on guard. Prompt action is imperative.

Type II

In this group the patient is ill from the very beginning. The surgeon has to decide whether he is dealing with a paralytic ileus or definite obstruction, a most difficult task. For the first three days conservative treatment with careful vigilance and evaluation of every symptom presenting itself may be permissible. Bailey warmly recommends enteroenterostomy [illegible].

If the condition, instead of improving is getting worse, do a jejunostomy or ileostomy. This should be done without further delay supplemented by gastric lavage and Miller-Abbott tube.

Type III

In this class of cases pools of pus accumulate in the pelvis, neighboring loops of small bowel become adherent in an effort to wall off or limit the extension of the process and intestinal obstruction results.

If the condition of the patient is still good, Bailey counsels the following:

"Through a supra-umbilical median incision, a coil of small intestine is found. If neighboring gut is free from peritonitis and not extensively adherent, we run the small intestine through our fingers until the commencement of the diseased area is reached. If the great omentum is well developed, a hole is made in it under its attachment to the transverse colon and the selected coil is brought through. If the great omentum is poorly developed, this step is omitted. Then using clamps, lateral anastomosis between the ileum and transverse colon is performed.

"Gastroenterostomy [illegible] in the type of case described would save many [illegible]. The operation is performed through an [illegible] area; the gut is free; the operation is a 'wet' one and should occupy a definite period of time which can be judged beforehand.

In desperate cases I have frequently resorted to simple enterostomy. In some instances, the results were gratifying.

OBSTRUCTION OWING TO MECKEL'S DIVERTICULUM

The diverticulum and its omphalomesenteric duct act here as a constricting band. Its distal extremity, normally usually free, may become attached to any point within the abdomen.

Guy Van Metyne reported[1] two interesting cases of intestinal obstruction resulting from strangulation from persistent obliterated omphalo-mesenteric ducts (Fig. [illegible]).

The obstruction may supervene in a variety of ways, each of which requires special treatment. Generally, however, the steps of procedure are as follows:

Step 1. Free the extremity of the diverticulum.
Step 2. Crush its enteric extremity a short distance from the intestine. Place catgut ligature around the crushed ribbon of tissue remaining. Remove the diverticulum.
Step 3. Superimpose a sero-muscular suture burying the catgut ligature. Reinforce the suture line with a free omental graft.

In a surgical experience of over thirty years, I have encountered only two cases where Meckel's diverticulum was the cause of intestinal obstruction.

Obstruction from an adherent appendix vermiformis may play a rôle similar to the type just described. Appendectomy is the treatment.

OBSTRUCTION DUE TO INTERNAL HERNIA

Segments of bowel may slip through apertures in the mesentery giving rise to strangulation. The treatment is obvious. Reduction of the incarcerated segment and closure of the opening in the mesentery. (Figs. [illegible].)

Apertures in the omentum and broad ligaments may also occasion strangulation.

INTRA-ABDOMINAL HERNIA
Hernia into the Retroperitoneal Fossae

1. Hernia of the foramen of Winslow.
2. Hernia of the duodeno-jejunal recess.
3. Hernia of the intercecal and ileocecal fossa.
4. Hernia of the intersigmoid recess.
5. Retrocecal hernia.

HERNIA OF THE FORAMEN OF WINSLOW

The hernia here finds its way into the lesser peritoneal cavity (Fig. [illegible]). The omentum may be regarded as a pre-existing hernial sac. Such hernias are rare because the opening is usually narrow. The portion of the

[1] Annals of Surgery, [illegible].

bowel becoming constricted is usually the colon but small intestine may also become strangulated.

A paramedian right upper incision is used. Endeavor to withdraw the intestine from the foramen. In case the herniated portion consists of large bowel, the cause is ascribed by Moynihan to an abnormal mobility of the cecum or ascending colon by reason of the presence of a common mesentery.

After disengagement of the herniated bowel, plication of the mesentery or cecopexy should be done. An effectual closure of the opening cannot be accomplished.

If there is difficulty of delivery of the incarcerated bowel, do an enterostomy first, to evacuate the intestinal contents. If further difficulty is encountered Moynihan and [illegible] advise division of the constricting neck by incising the peritoneum as it passes from the duodenum to the posterior abdominal wall. This mobilizes the duodenum which can now be displaced downward and the ring enlarged.

Fig. [illegible]. Guy Van Metyne. [illegible] intestinal obstruction due to persistent omphalo-mesenteric ducts.

HERNIA THROUGH THE DUODENOJEJUNAL FOSSA

The orifice of this fossa looks upward. It is formed by a peritoneal fold and is usually to the left of the spine at the duodenojejunal junction (Fig. [illegible]). In many instances it may contain all of the small intestine projecting behind the posterior parietal peritoneum. The duodenum can be observed to enter the sac and the beginning of the ileum to leave it. The renal artery is behind the sac and the inferior mesenteric in front of it (Treves). The inferior mesenteric vein and occasionally the left colic artery run at the upper border of the aperture.

Make a paramedian incision through the left rectus abdominis muscle. The neck lies to the right of the sac, to the left of the third lumbar vertebra. Attempt reduction, which at times may be easy. If difficult, divide the neck of the constriction, cautiously. Avoid injury to the inferior mesenteric vein and left colic artery. After reduction attempt closure of the neck. Removal of the sac is impracticable.

THE RIGHT DUODENOJEJUNAL FOSSA

is situated in the mesentery at the very beginning of the jejunum below the duodenum. Its opening faces to the right. The superior mesenteric artery runs in its free edge. In dealing with hernia of the paraduodenal fossae one must remember the presence of important vessels in their free border. When reduction fails, the neck of the hernia should be divided in an avascular area.

HERNIA INTO THE FOSSAE ABOUT THE CECUM

The disposition of these fossae is shown in Fig. [illegible]. They consist of the

1. Ileocecal fossa,
2. Ileo-appendicular fossa,
3. Retrocecal fossa,

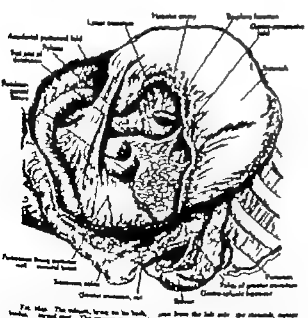


Fig. [illegible]. The stomach, drawn to the left, [illegible] from the left side, the stomach, [illegible] [illegible]. The [illegible] omentum has been cut below the greater curvature of the stomach so as to open the lesser sac to show the foramen of Winslow from the left side. ([illegible].)

Hernias here are very rare. Usually when occurring, they are found in the retrocecal fossa extending upward behind the cecum and ascending colon. Coils of the lower ileum may find their way here.

The pericecal fossae are comparatively avascular. If reduction fails, the neck of the hernia may be divided with comparative impunity. After reduction the fossa should be obliterated with catgut sutures.

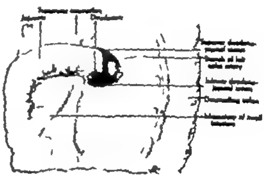


Fig. [illegible]. Duodeno-jejunal [illegible] [illegible] [illegible] fossa; jejunum turned to the right.

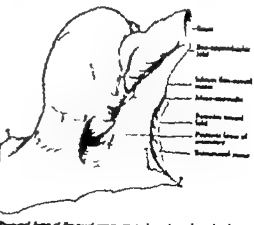


Fig. [illegible]. [illegible] form of ileo-cecal region, [illegible] being [illegible] [illegible] and [illegible]. ([illegible].)

HERNIA INTO THE INTERSIGMOID FOSSA

This space is exposed by raising the sigmoid flexure and retracting it to the left. It will be found opening toward the left between the root of the sigmoid mesocolon and the parietal peritoneum. Coils of small intestines may find their way into this fossa.

The relation of the sigmoid artery must be kept in mind in endeavoring to reduce a hernia in this locality.

Fig. 1643. The loop shown has been reduced, detorsion has been done and the opening in the mesentery is ready to be closed.

The plica hypogastrica may form a deep peritoneal pocket forming a retrovesical hernial pouch.

Strangulation may also be occasioned through:

1. A hole in the falciform ligament of the liver.
2. By a Fallopian tube or long pedicle of an ovarian cyst.
3. Holes in the mesentery (Fig. 1643) or omentum may occasionally result in intestinal obstruction.

IMPACTION OF FECES

If accumulation of fecal matter obstructs the onward passage of the current, occasioning symptoms, disimpaction should be done (following oil enemas, breaking up of impacted mass with gloved fingers or spoon).

TORSION OF THE OMENTUM

When this causes intestinal obstruction it is treated by (a) detorsion and (b) resection of omentum.

OPERATIONS FOR INJURIES AND PERFORATIONS OF THE BOWEL

Either injury or disease may cause solution of continuity in some part of the intestinal tube. One can never be sure that there exists no intestinal perforation

Thomas, Mass. Med. Jour. and Record, June 1930.

because of absence of external evidences on the abdominal surface. It is far better to err on the side of safety and adopt unreservedly the dictum "When in doubt explore." I have met many surprises by adhering to this dictum and was often painfully reminded of the fallibility of human judgment. Of course, where penetration of the abdomen has taken place, the indications for operation are clear.

Make a median incision between the umbilicus and the symphysis pubis. Observe the condition of the peritoneum. If gas escapes endeavor to ascertain by the sense of smell whether large or small bowel has been perforated.

Search for the point of injury. If not readily ascertained explore the small intestine from below upward and the large intestine from the cecum downward. While so doing, mop up, or use the suction apparatus for the removal of, escaped intestinal contents.

When the Point of Perforation Is Found

Avoid further escape of intestinal contents. To accomplish this, wrap the affected segment of bowel in a hot lap pack, pull the injured bowel forward and have an assistant hold it, or engage the affected loop of bowel in a Doyen intestinal clamp. Isolate the rest of the abdominal cavity with warm lap sponges. Always keep the possibility of multiple intestinal perforations in mind.

Fig. 1644. Closure of gunshot injury to the intestine.

PUNCTURED WOUNDS

These should be closed with a purse string suture (Fig. 1644). Superimpose a Lembert seromuscular stitch placed transversely to the long axis of the bowel.

Incised wounds are repaired by two rows of sutures: (a) an inner through-and-through catgut suture and (b) an outer inverting seromuscular Lembert line of sutures.

LACERATED WOUNDS

Devitalized borders must be excised before suture is attempted. Repair should be accomplished by two-layer sutures placed transversely to avoid constriction of the bowel. Where much of the intestinal wall is injured resection may be the preferable operative procedure.

Wherever free blood or actual bleeding is encountered, the latter must at once be stopped and all free blood clots removed: they form excellent pabulum for escaped microorganisms. These clots must be cleared away before suturing of the bowel is done.

Before closing the abdomen make sure that no perforation has been overlooked. If in doubt, eventrate and explore, and be sure!

Small bowel perforations are usually easily found. Perforations in the large bowel are often discovered with difficulty.

Ladenhau advises, in suspected large bowel perforations, or lacerations, to systematically explore the large intestine in the following order: pelvic colon,

colon descendens, transversum, the beginning of the small bowel to the cecum and finally the ascending colon.

In multiple perforations of a given segment of bowel, it is better to resect that portion instead of attempting to close each perforation separately.

Areas of crushed bowel without actual perforations must be excised and the bowel reconstructed in healthy tissue.

Portions of bowel detached from the mesentery should be resected.

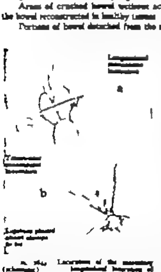


Fig. 1645. Laceration of the mesentery (schematic): a, longitudinal laceration of the mesentery at right angles to the bowel, usually easily closed. A long transverse laceration compromising the blood supply of the bowel necessitates resection. b, Method of approximating the edges of the mesentery. The edges are held in approximation and ligatures placed.

Large bowel defects are difficult to handle for the following reasons:

1. Difficulty in delivering the affected portion of bowel (short mesentery).
2. Difficulties in suturing.
3. Facility of infections.

Defects must be securely repaired. A number of layers of sutures, reinforced by omental grafts should be the rule. Never omit to drain after repair of defects of the large bowel.

In extensive lacerated injuries of the intestines, resection should be done (for technic see page 1463). If the condition of the patient is precarious do a Bloch-Paul-Mikulicz two-stage operation.

INJURY TO PORTIONS OF BOWEL WITHOUT MESENTERY

Duodenum, Colon Ascendens and Descendens

Injuries of these bowel segments may be extraperitoneal and thus even more dangerous than intraperitoneal injuries.

Local emphysema beginning in the flank and spreading to the front is a comparatively early symptom. Colostomy here is often life saving. It should be performed early. In injuries to the duodenum the reflection of the peritoneum is bile stained. Hematuria speaks for retroperitoneal large bowel injuries.

Treatment

Explore thoroughly. Leave nothing to chance. Mobilize the affected segment of bowel. Close the perforation thoroughly. A lumbar drain should never be omitted. Protect the peritoneal cavity during the operative manipulations. Resuture the parietal peritoneum. Remember the drain should never be brought into direct contact with the suture line.

Never operate during shock. Use all possible measures to counteract the primary circulatory depression, then proceed to operate.

LACERATIONS OF THE MESENTERY

In lacerations that run parallel to the axis of the intestine (Fig. 1645 a) the nutrition of the intestine is jeopardized. If such laceration be over two inches in length, resection with anastomosis should be done. Even smaller injuries which show only a slight discoloration of the intestine indicating interference of circulation call for resection.

Longitudinal lacerations should be closed by interrupted ligatures (Fig. 1645 b). The results are good.

Hematoma of the Mesentery

A hematoma may strangulate the intestine and cause its death. Where hematoma is present it should be subjected to the following treatment:

See if the hematoma is present on both sides of the mesentery. If so, aspirate its contents. If aspiration causes a reformation of the hematoma the vessel is surely bleeding. Open the hematoma. Find the bleeding vessel and ligate it.

Scrutinize the nutrition of the bowel. If impaired, consider resection.

INJURY TO THE BOWEL WITH PERFORATION OF THE ABDOMINAL WALL

In these cases matters are complicated by the introduction of septic material from without.

Treatment

Step 1. General anesthesia.
Step 2. Excise the ragged borders of the wound.
Step 3. Explore.

Treat as indicated above.

Keep in mind the possibility of injury to the structures in the retroperitoneal space. Make sure that the pancreas has not been injured by a bullet. If so, attempt to remove the bullet; if that does not seem feasible drain the retroperitoneal space and region of the pancreas.

When omentum and bowel are prolapsed, do not replace these without first repairing the damage done and supplement this by thorough disinfection and drainage, if need be.

SURGERY OF THE APPENDIX

Some aphorisms of pioneers in the surgical treatment of appendicitis may not be amiss here:

"The physician treats appendicitis, the surgeon cures it." (Kümmell.)

"There is no medical treatment for appendicitis." (Fowler.)

Concerning the so-called conservative treatment of appendicitis, Ochsner pointedly asked, "*What do you wish to conserve, the patient or the appendix?*"

Von Eiselsberg concludes: "Early operation is the ideal method of treating appendicitis."

Pothecot admonished: "Operate, do not wait for the appendix to suppurate

Dieulafoy stated: "On ne doit pas mourir d'appendicite" (one should not die from appendicitis) and

Kocher said, in substance, that he would suffer from no scruples because he had removed a hundred apparently normal appendices but would suffer remorse when losing a patient from appendicitis because of procrastination.

Every experienced surgeon will concur in the conclusions drawn by D. P. D. Wilkie:

The mortality from appendicitis remains as high as it was twenty years ago because while facilities for treatment have improved, diagnosis in the fatal type of case has not.

There is now very strong evidence that the fatal cases of acute appendicular disease are primarily cases of obstruction of the appendix and not inflammation. It is necessary to distinguish between these two types of acute disease the clinical symptoms and essential pathology of which differ widely. The obstructive cases must be regarded and treated as belonging to the same category of urgency as internal strangulation of the intestine.

3. Free exposure at operation is essential.

4. While immediate operation is expedient in the early stages of appendicitis, delay is advisable in the resolving case, the danger of operation being greater than that of expectancy.

5. When a large localized abscess is present, simple drainage with minimal disturbance is the safest line of treatment.

6. In cases with perforation and peritonitis, infection of the abdominal wound may be an important factor in determining a fatal issue. Open treatment of the wound is therefore advisable.

7. Postoperative obstruction accounts for a number of deaths. A timely enterostomy or ileostomy may prove a life-saving measure.

APPENDECTOMY (APPENDICECTOMY)

Removal of the Appendix in the Quiescent Period

Anesthesia. General, local or spinal.

In the early nineties when McBurney described the muscle-splitting operation commonly spoken of as the gridiron incision (or as Roux referred to it as "l'incision ménagère") he recommended that that incision should be used in interval cases only and stressed the point that it should not be used in acute cases. For reasons I cannot fathom the incision gained in popularity when it should have been discarded.

I am convinced it is a dangerous incision except on rare occasions as it often places the surgeon in an embarrassing position, particularly when complications exist such as abnormal location of the appendix, wrong diagnosis, adhesions, etc.

It is surprising that recent literature shows reports by competent writers who claim that the use of the McBurney incision lowers mortality but they do not offer satisfactory explanation as to the reason for the alleged lowered mortality.

While the pendulum has been swinging back and forth as to the merits and demerits of that incision, many experienced surgeons maintain that it is a com-

Int. Med. Jour. Feb., 1932

plicated procedure and should be resorted to only in exceptional cases, viz., in interval operations for the removal of the appendix where the diagnosis is incontrovertible. Apropos of the surgical approach to the appendix, we read in Romanis and Mitchiner's "Science and Practice of Surgery":

The oldest incision, which is now quite out of date, is the muscle splitting incision of McBurney. Here an oblique incision 3 inches long parallel to and an inch from the outer half of Poupart's ligament was made. The abdominal muscles were then split in the direction of their fibers and the peritoneum opened. This had the advantage of lying directly over the appendix and cutting no muscles. It had no other merits, however and many disadvantages. It was quite impossible to enlarge it satisfactorily without damaging muscles and no examination of other abdominal organs could be made through it. Moreover it is much more painful than the other incisions. As soon as it was realized that there were very few cases in which mere appendectomy sufficed, and that in practically every case an examination of other abdominal organs should be made, this incision fell out of use except for opening appendicular abscesses. The practice of removing appendices through small inch McBurney incisions of which some surgeons boast, is quite undesirable and a mark of total lack of surgical balance.

Roger T. Vaughan states:

"The surgeon who operates on female patients for appendicitis routinely through a McBurney incision is bound to overlook considerable pelvic pathology besides ruptured Graafian follicles and corpora lutea. Both the Battle and the right paramedian incisions are preferable where the clinical picture of appendicitis is not typical."

A. B. Yerbury[1] states: "In the early '90s McBurney described the muscle-splitting operation which is known as the 'McBurney Method.' It is of interest to note that McBurney used this only in interval cases and laid stress on the point that it should not be employed in acute cases. At present it is used by most surgeons in acute cases, and some other incision is used where any exploration is contemplated or the diagnosis is at all doubtful."

This is not entirely in accord with the author's observations to which I would like to add that the beginner particularly will do well to look upon the McBurney incision as one which invites him to pitfalls which he can ill afford, particularly on the threshold of his surgical career. Inguinal hernias are invited when the McBurney incision is used because of injury to the nerve supply of the region under discussion.

Step 1. Incision (Fig. 1648). The simpler the incision the better. Exposure should be ample. Two or three decades ago surgeons were proud of the small incisions through which they were able to remove an appendix. Such foolhardy display to which the writer also was no stranger cost many lives.

I have completely discarded the use of the McBurney incision. It should be of historical interest only. It has no merits and many disadvantages to its credit. True, when the appendix is in its classical position the McBurney incision permits exposure without dividing the abdominal muscles. The story is different when the appendix is retrocecal, is or near Morison's pouch, displaced to the left or in any other unusual position (Fig. 1647). Under such conditions

[1] Johnson Op. Ther., 1925 Vol. II.

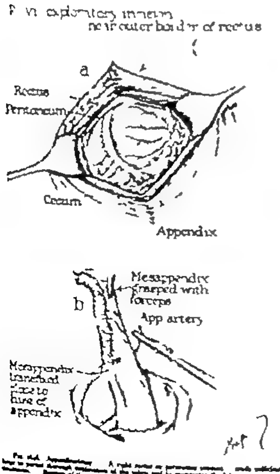


Fig. 1648. Appendectomy. A right rectus or paramedian incision [illegible]

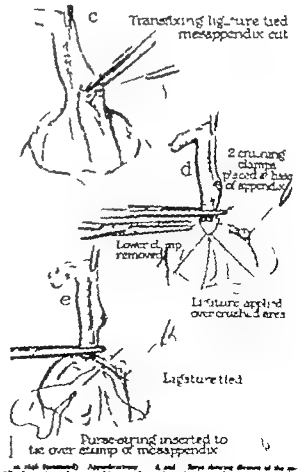


Fig. 1648 (Continued). Appendectomy. [illegible]

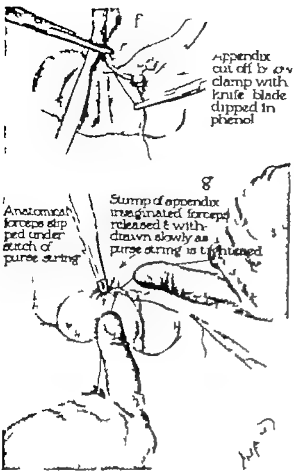


FIG. [illegible] (continued). Appendectomy. f, and g. Amputation of appendix; invagination of stump.

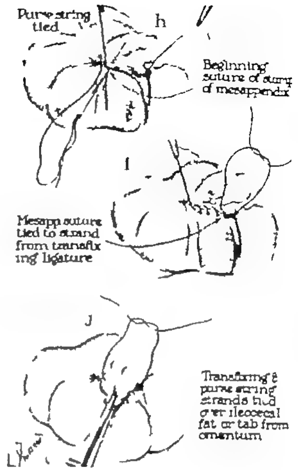


FIG. [illegible] (continued). Appendectomy. h, i and j. Stump of mesappendix sutured and covered with fat.

it is quite impossible to enlarge the opening satisfactorily without damaging the abdominal muscles. Besides, McBurney himself advised not to resort to this incision in acute cases. Thorough abdominal exploration is impossible through the McBurney incision. No experienced surgeon is nowadays satisfied with simple removal of the appendix when, knowing as he does, or should know, that many other pathologic conditions may be present besides diseased appendix, the latter often playing a subsidiary rôle in the actual picture.

The Paramedian and transverse incisions are simple. They may be enlarged when need be (upward or downward) for exploration of other viscera, or to deal with complications where proper exposure is essential. They have

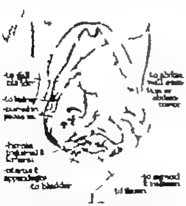


FIG. [illegible]. Composite diagram showing appendix in various parts of abdominal and pelvic cavities. (Modified from Kelly Hurdon.)

much to recommend them. The paramedian incision is made over the rectus abdominis muscle. In this incision the rectus sheath is opened and the rectus abdominis muscle retracted laterally.

In America we often speak of paramedian incisions as "trap-door" incisions. Here also, numerous writers lay claim to priority (Lennander, Kammerer 1897, Jalaguier—1897 etc.)

Trap-door incisions make bad portals where suppurations are encountered and drainage becomes necessary.

The transverse incision should always be used in females (possibility of adnexal pathology). This is placed [illegible] cm. lateral to the linea alba and after incising the anterior sheath of the rectus abdominis muscle, its fibers are split longitudinally. The posterior sheath of the rectus and peritoneum are next divided longitudinally.

Step [illegible]. Locating the Appendix. The ileocecal segment of bowel is identified and delivered.

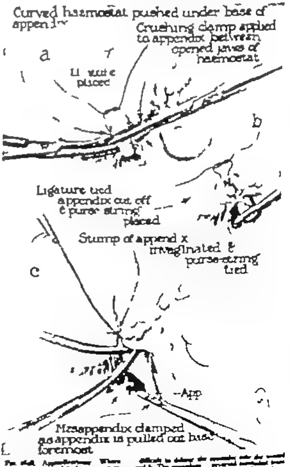


FIG. [illegible]. Appendectomy. [illegible]

Finding the appendix may be simple or most difficult. There are numerous aids for its identification. Follow [illegible] longitudinal band of the intestine downward and it will lead to the junction of the appendix. If the appendix is not obscured by adhesions, it may be found in any position about

Fig. [illegible]. Appendix. [illegible] [illegible], [illegible] [illegible] [illegible] or gallbladder. Operative findings: [illegible] appendix of [illegible] [illegible]; tip of appendix attached to under surface of liver.

the cecum, curled up on itself or extended. Adhesions, if present, are gently separated and the appendix [illegible] delivered into the wound.

In cases where the appendix is difficult to deliver resort to retrograde dissection, viz., separating the appendix from its base first and inverting the stump with [illegible] purse string suture. Detachment of the appendix proceeds toward the tip instead of the reverse, as is usually done (Fig. [illegible]).

If the taenia longitudinalis does not lead to identification of the appendix, sweep the finger across the iliac fossa until the iliac vessels are recognized. Continue with the finger upward until it is stopped by the mesentery of the terminal ileum. Follow this outward and invariably the ileocecal junction will be found which is brought out of the abdomen. Do not work blindly. If these methods of delivery fail, remember the possibilities of nondescent or nonrotation. Explore the subhepatic or left lower abdominal quadrant (Figs. [illegible]).

Fig. [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible].

As soon as the appendix is delivered only the parts concerned in the operation are permitted to remain exposed, the rest of the abdominal cavity is packed off with moist lap packs of proper temperature.

The Cecum Is Delivered and No Appendix Is Visible. Explore the posterior portions of the terminal ileum or cecum. Mobilize the cecum by dividing the line of its peritoneal reflection along its lower and outer margins. Roll the cecum inward and pull it upward and search carefully. Diligent search will often be rewarded by finding the appendix lying in the loose, retroperitoneal tissue or intimately united by adhesions to the posterior wall of the cecum—the retrocecal appendix.

Under such conditions, locate, ligate and divide the stump of the appendix at its base. Then cover it between the ligature and an artery forceps at the

distal part. Superimpose [illegible] purse string suture around the ligated stump. Ligate the blood vessels in the mesoappendix which is often absent in these cases, working from the base to the tip. The important point to remember in removing retrocecal appendix is that the appendicular blood vessels are attached medially to the appendix and dorsal to the cecum, colon and to their vessels. (Fig. [illegible] a, b, c.)

If there is suspicion of abscess, protect the abdominal cavity with gauze pads, one placed laterally to the cecum and one below it.

If the cecum is not visible when the peritoneum is opened, insert the index finger, direct it outward and glide it along the ventral and then the lateral wall of the abdomen. Lift the cecum into the wound. The base of the appendix may be located by following down the ventral taenia longitudinalis.

If the cecum is not found, glide the finger across the iliac fossa to the iliac vessels, thence upward to the mesentery of the terminal ileum. Follow this outward and locate the ileocecal junction. Wherever possible, roll the cecum out of the wound. It will facilitate the maneuvers necessary for the removal of the appendix. The [illegible] fold which runs from the terminal ileum to the cecum frequently serves as [illegible] landmark.

If the ileocecal junction has not been identified after following the above suggestions, make search in the subhepatic or left lower quadrant.

If the cecum is discovered but no appendix found, search for it behind the cecum or terminal ileum. If not found, mobilize the cecum by incising the line of the peritoneal reflection along its external border. Roll the cecum forward and upward and the appendix will usually be found in the retroperitoneal areolar tissue or in the posterior wall of the cecum.

If the appendix is retrocecal, divide it at its base between two ligatures or clamps. Cauterize both ends and take care of the stump. Ligate the vessels from the base to the tip and remove the appendix. In removing retrocolic or retrocecal appendix remember the position of the vessels (lying ventral to the appendix and dorsal to the cecum and colon and their vessels).

Robert L. Payne[4] pointed out that there were straight vessels situated on the terminal ileum hitherto undescribed which are definite anatomic features of this particular portion of the intestinal tube (Figs. [illegible]). This enables the surgeon to recognize at [illegible] glance the last ½ inches of the terminal portion of the small bowel by the straight course of the vessels alluded to. It is interesting that beginning at the pylorus and extending down the entire small bowel to [illegible] point ½ inches from the ileocecal valve, the visible blood vessels run at right angles to the long axis of the bowel—passing up from the mesentery on the convex surface of the bowel to unite at [illegible] point opposite the mesentery. In the terminal portion of the ileum, however, one to three small straight vessels spring from the anastomosis formed by the ileocolic and right colic branches; these branches extend upward from the ileocecal valve just under the peritoneum and parallel to the long axis of the bowel for [illegible] distance of one-half to one and one-half inches or thereabouts. Also, these vessels are end-arteries and run immediately underneath the peritoneal coat in contradistinction to the other blood vessels supplying the small bowel which run between the mucous

[4] Surg., Gyn., Obst. [illegible].

and submucous coat. Payne has observed the frequency of this finding in [illegible] consecutive celiotomies. This feature affords the surgeon an easy method of locating the appendix using the last 1½ inches of the terminal ileum as [illegible] guide to the base of the appendix. It is more practical than locating the appendix by following the taenia longitudinalis downward.

Step 3. Ligation of the Mesoappendix. (Fig. [illegible], see p. [illegible].) Be sure that the mesoappendix and the appendicular artery with it are securely ligated. Divide the mesentery at [illegible] little distance from the point of application of the ligature to prevent the latter from slipping. Often the mesoappendix will have to be ligated in small sections. This is particularly true in the retrocecal or retrocolic type of appendix.

Fig. [illegible]. Sketch from living specimen showing [illegible] straight vessels on last [illegible] and one-half [illegible] running parallel with the long axis of small bowel. Sometimes only one or two vessels are found present.

Fig. [illegible]. [illegible] [illegible]. A [illegible] [illegible] of [illegible] [illegible] or appendix [illegible] may be [illegible] by [illegible] of the terminal ileum which [illegible] [illegible] by the longitudinal [illegible] [illegible] the transverse branches of blood [illegible] in the [illegible]. (Courtesy of Dr. R. L. Payne.)

Step 4. Treatment of the Stump. (Fig. [illegible] d, e, f, g.) Wrap the appendix in [illegible] gauze dressing. Place two clamps at its base. The artery forceps next to the cecum crushes the appendix. Ligate the crushed ribbon thus produced with [illegible] catgut ligature. Prior to the division of the appendix [illegible] purse string suture is applied around the prospective stump. Dip scalpel in carbolic acid and section the appendix about [illegible] quarter of an inch from the ligated base. The remaining mucosa of the stump should be thoroughly cauterized. Wipe off the excess of carbolic acid.

After the appendix is cut away an anatomic forceps steadies and depresses the stump which is buried while the purse string suture is being tied. In the region of the mesentery the needle carrying the purse string suture must pass under the blood vessels so that when the ligature is tied the vessels are included. It is [illegible] good precaution to superimpose [illegible] Lembert seromuscular suture or another purse string suture (Chrisman) over the first one. The mesoappendix may be sutured over the point of the invaginated appendix. Fig. [illegible] h, i, j, page [illegible].

Other Methods

A number of other methods are practiced for the care of the stump, each having its advocates.

SIMPLE LIGATION OF THE APPENDIX

Baldwin of Columbus, claims for this simplicity and rapidity besides avoiding contamination incident to the penetration of the mucosa by the needle carrying the purse string suture, [illegible] penetration which cannot always be avoided. Harkness[5] is also an advocate of the Baldwin method of procedure. Turck[6] reports two cases of intestinal obstruction following this method.

Commenting J. Shelton Horsley in commenting on the inversion of the stump of the appendix, has the following to say:

"There was formerly much discussion about the best method of treating the stump of the appendix. Dr. John A. Wyeth merely tied the stump of the appendix with silk and cauterized it with carbolic. After doing this for [illegible] few years, I became convinced that the technic of burying the stump was unnecessarily complicated and was really more dangerous than the simple treatment of the stump; so about twenty-five years ago I went back to the original procedure of merely ligating the stump and treating it with carbolic acid. Lately I have often drawn [illegible] small section of peritoneal covered fat over the stump with the end of the ligature around the base of the appendix, but at no time for twenty-five years have I attempted to invert the stump with any purse string suture or any suture in the cecum itself.

While this simpler technic has been unpopular it seems to be gaining in favor. Until recently the practice at the Mayo Clinic was to bury the stump of the appendix. The following is [illegible] quotation from Dr. Charles W. Mayo, of Rochester which appears on page [illegible] of the February number of Southern Medicine and Surgery. In view of the great number of appendices that are removed at the Mayo Clinic and the careful observation of the pathologists who have charge of the postmortem examinations, this statement should attract much attention.

"There are four reasons why I do not invert the cauterized stump of the appendix: (1) Dr. Robertson of the Section on Pathologic Anatomy at the Clinic, has found that invariably in cases in which appendectomy with inversion of the stump has been done in combination with some other surgical procedure and death has resulted, there is [illegible] pus pocket in the inverted stump up to twenty-one days postoperatively; (2) the sutured suture material used to invert the stump, once having run through the intestinal wall, invariably is infected with pathogenic bacteria; (3) non-inversion shortens the surgical procedure, and (4) I have not had occasion to regret not having inverted the stump.

Where the wall of the cecum is indurated about the base of the appendix it may be impossible or inexpedient to use [illegible] purse string suture.

[5] Ind. J. Clin., [illegible], [illegible]
[6] Ind. J. Clin., [illegible]
[7] So. Med. [illegible], Vol. [illegible], March, [illegible].

Simple ligation, the conversion of operators has it, is not as safe as invagination. Should the ligature slip or give way danger is not far away.

Step 5. Inspection. I recall one instance where I lost a patient from insecure hemostasis at the stump of the mesoappendix. Since then I refer to this point as the "death angle" and impress my assistants with the importance of never replacing the ileocecal segment without making sure that hemostasis is secure and that a poorly inverted stump has not, perhaps, escaped inversion.

Step 6. Cover all raw surfaces with peritoneum.

Fig. 1463. In removing the appendix through a McBurney incision adhesions are sometimes so displaced, ... occasionally resorted to. Deep adhesions ... the superficial block after the incision ... made.

Step 7. Replace the bowel into the abdominal cavity.

Step 8. Close the abdominal wound in layers. Drain the wound.

Acute Appendicitis

The rule I adopted, based on the statistics of careful observers and experienced surgeons and my own studies, is as follows: As soon as the diagnosis of acute appendicitis is made, regardless of its type, the appendix should be removed, the sooner the better. This rule however applies to the first 72 hours. After that, the delayed (Ochsner-Sherren) treatment of conservatism should be practiced.

Step 1. Anesthesia and incision as before; occasionally block anesthesia is used (Fig. 1463).

Step 2. Remove accumulated fluid with the suction apparatus. Pack off the general peritoneal cavity with gauze lap sponges, leaving the field of operation well isolated. Excessive sponging does more harm than good. During the early hours of peritoneal inflammation the accumulated fluid ... made up largely of serum rich in antibodies and leukocytes. Later the fluid becomes

turbid owing to dead tissue elements and bacteria. This should be removed by suction. The important thing is to have the general peritoneal cavity well walled-off.

Step 3. Delivery of the appendix. (See p. 1431, Step ...)

Step 4. Ligate the meso-appendix as described above. If the mesoappendix is gangrenous, the suture will cut out. Careful hemostasis with sutures (not ligatures) is essential.

When the appendix has sloughed off, thrombosis of the vessels in the mesoappendix is so marked that no bleeding will be encountered. Retracted bleeders should be caught out and ligated.

Step 5. Removal of the appendix from point to base or in ... retrograde manner should now be done as described above. Should these cases be drained? I have adopted the following practice: If the amount of fluid is inconsiderable and the visceral peritoneum only slightly altered (congestion, luster) I close the abdomen. In the majority of cases, however ... has the fluid is turbid and the peritoneum has lost its luster or ... has the appendix has ruptured during its removal and its contents soiled the peritoneum, I drain.

When conditions in the next day or two are promising and drainage is slight I remove the drain ... with no appreciable delay in the convalescence.

At the Cook County Hospital, in Chicago, some surgeons of the staff (Karl Meyer, Raymond McNealy and others) advise against drainage and obtain excellent results. Meyer

removes the appendix

2. mops up the accumulated fluid and

3. closes the peritoneum.

Raymond McNealy proceeds as outlined but does not close muscle, fascia or skin. He sutures the peritoneum only and permits the rest of the abdominal wall components to fall evenly together. The results leave nothing to be desired.

Despite these excellent results, however ... have continued with similar conditions, ... subconscious dictates always seems to admonish me: "If you are in doubt, drain."

ACUTE APPENDICITIS WITH ABSCESS

The passive excess holds as good today as on the day when it was first observed. Yet, small collections of pus ... about marked physical manifestations may be permitted to be resorbed ... about surgical interference, under watchful expectant care. But such expectant treatment must be, as Bailey aptly puts it, carried out by the surgeon himself on the threshold of the operating theater.

Indications for drainage.

The abscess does not decrease after a week but remains stationary.

There is ... sustained hectic temperature with marked systemic manifestations.

3. Fluctuation is present. (Do not wait for fluctuation to appear.) Be guided by the size of the accumulation and general symptomatology.

Pelvic abscess develops.

Do not omit rectal examination! Valuable information is thus gained.

Appendicular Abscesses vary in position depending upon the position of the appendix. Moynihan has operated for appendicular abscess on the left side.

Fixed, hard masses, akin to those encountered in ... [illegible] are better left alone and should be treated by what Bailey aptly terms "masterly expectancy."

Anesthesia. Infiltration or nitrous oxide-oxygen will usually suffice.

Incision. This should be made over the most prominent part of the accumulation of pus, no matter where located (anterior, retrocecal, subphrenic, etc.). This rule should be strictly adhered to. A finger should be introduced into the opening made and the abscess cavity explored. Pelvic and intercolic extensions are thus discovered and properly treated. If the general peritoneal cavity has inadvertently been opened, close it at once and pack the area away, ... from contamination during the evacuation of the pus. A lateral approach is desirable for if the incision be overlying the mass, severe hemorrhage may result from injury to the omental vessels. In exploring an abscess cavity it must be remembered that the greatest care is to be taken to avoid breaking down protecting adhesions. Evacuation of the pus should be accomplished by the use of ... good suction apparatus. Should the appendix be removed? If encountered and easily brought to the surface ... should be removed. If its isolation and delivery are beset with difficulties, leave ... alone (Fig. 1464b).

After evacuation of the pus, drainage is to be instituted which must be thorough. Properly placed drainage tubes are ideal for the purpose, for upon thorough drainage depends the success of the operation. If the abscess extends laterally and upward, counter-drainage through the loin for intercolic or retrocolic accumulations should be done; rectal or vaginal drainage may be indicated.

Do not be in ... hurry to remove drainage tubes. Disregard of this rule may lead to ... premature closure of the wound with reformation of the abscess.

Retrocecal abscesses often assume large proportions. They may be approached as follows:

Extraperitoneally (Figs. 1464 a, b ... 1465 ...). To reach the extraperitoneal cellular tissue the incision is made ... inside ... above Poupart's ligament and gradually deepened until the abscess cavity is reached without endangering the peritoneum.

When ... Pelvic Abscess Has Developed

It may be approached in the male

Through the rectum (Fig. 1496).

In the female, through the vagina (see posterior colpotomy). The suprapubic approach to ... collection of pus in the pelvis ... always preferable to evacuation of the purulent collection through the rectum. The latter ... blind procedure, the former more exact. To ... utilize the rectal approach the surgeon must be thoroughly convinced that the diagnosis is correct and that he ... not dealing ... conclusive that simulate collections of pus in the pelvis (distended bowel in the male, adnexal collections in the female). If the diagnosis ... doubtful, approach through the abdomen and ascertain whether the mass is thoroughly walled-off and whether it communicates with the general peritoneal cavity.

Lithotomy position. Dilate the anus fully. Outline by palpation the projecting mass and ascertain its point of fluctuation. Incise the rectal mucous membrane through the incision thus made, perforate the intervening tissues with blunt dissector or artery forceps (Fig. 1496). As soon as the abscess is reached

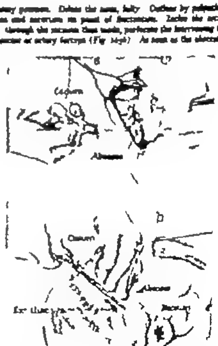


Fig. 1464. Transperitoneal approach with extraperitoneal evacuation of appendicular abscess. If the abscess ... found immediately by an extraperitoneal route, ... small incision ... made to the right but lateral to the first. Through this secondary incision ... drainage ... the abscess ... reached. The incision ... packed ... and ... through the abdominal incision. Contamination of the general peritoneal cavity may thus be avoided. A drain is ... the ... of ...

pus will issue. Dilate the opening. Do not introduce ... drainage tube. It serves no purpose for the entrance of fecal matter. Careful dilatation with the finger as often as needed, is preferable to ... tube.

When the Vaginal Route is Chosen. The same technic is employed as in posterior colpotomy (which see).

Acute Appendicitis with Progressive Retroperitoneal Peritonitis

This form of the disease is grave from the very beginning. I have but [illegible] recovery in this type of disease.

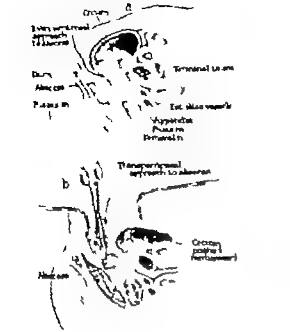


Fig. [illegible]. [illegible]

Explore gently.
If no difficulties present, remove the appendix. Evacuate the pus by suction. Drain.

CHRONIC APPENDICITIS

Comment. Warren H. Cole[illegible] points out that "The term chronic appendicitis is [illegible] from the [illegible] standpoint [illegible] chronic inflamma-

[illegible]

tion of the appendix produced by the same organisms which cause acute appendicitis is extremely rare. However, because of common usage and the lack of a better term it may be applied to such conditions as fecaliths, strictures and kinks due to adhesions, all of which [illegible] may produce mild chronic pain in the right lower quadrant. The actual number of cases of chronic appendicitis is considerably smaller than generally appreciated. An enormous amount of difficulty may be experienced in arriving at a correct diagnosis because of the paucity of manifestations and the similarity of the symptoms to those caused by many other diseases. For that reason, thorough examination of the patient is necessary. When operation is

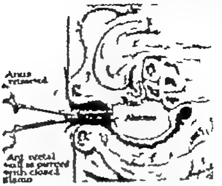


Fig. [illegible]. [illegible]

performed, the incision must be made near the midline and large enough to allow a thorough exploration of the abdominal cavity.

SURGERY OF THE RECTUM AND ANUS

Anatomic Considerations. Cancer of the rectum may involve any portion of the terminal bowel. It is most frequent at the rectosigmoid junction [illegible] in frequency is the ampulla and least is the anal portion. It is essential to thoroughly understand the blood and lymph supply as well as the anatomic peculiarities of the region in question.

Blood Supply of the Rectum (Figs. [illegible]). Arteries. The inferior mesenteric artery gives rise to the superior hemorrhoidal which runs in the pelvic mesentery and divides opposite the junction of the pelvic colon with the rectum into two branches which pass downward along the walls of the rectum. The middle hemorrhoidal ( ) derived from the internal iliac, and the inferior hemorrhoidal ( ) which are derived from the internal pudic. Occasionally an additional supply is derived from the sacra media.

Veins. The veins of the rectum show a marked disposition to the development of varices (hemorrhoids) near the anus. The veins lie in the loose submucous tissue between the muscular layer and the mucous membrane. From here they ascend

in the submucosa of Morgagni to form a dense plexus in the lower part of the ampulla, in the so-called "pile-bearing area." The vessels coming from the plexus [illegible] the [illegible] and [illegible] the superior hemorrhoidal veins.

Nerve Supply. They are derived from the hypogastric and sympathetic plexuses and the second, third and fourth sacral nerves.

Lymphatics. There are (a) intramural and (b) extramural. The extramural lymph vessels [illegible] lymph nodes which lie between the wall of the rectum and the [illegible]. The [illegible] vessels pass ( ) across the [illegible] to the internal iliac lymph nodes, ( ) across the upper surface of the

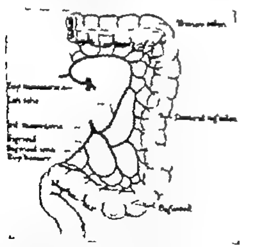


Fig. [illegible]. Blood supply of the lower segments of the large bowel.

levator ani to the internal iliac glands. (3) [illegible] to the nodes behind the rectum [illegible] lymph nodes). ( ) upward along the superior hemorrhoidal vessels to the [illegible] and upward to nodes at the bifurcation of the left common iliac artery and thence to the lymph nodes along the big vessels up to the nodes at the origin of the superior mesenteric artery.

Extension of carcinoma of the rectum is by the lymphatics. W. E. Miles describes three zones of spread. (a) Zone of downward spread involving the perianal skin, the [illegible] fat and the external sphincter ani. (b) Zone of lateral spread involving the levator ani muscles, the sacral and internal iliac lymph nodes, the base of the bladder and the seminal vesicles. In women the posterior vaginal wall, the cervix, and base of the broad ligament also are involved. Miles mentions especially a lymph node situated on the [illegible] artery where it crosses the [illegible] the so-called [illegible] gland. This is often involved in carcinoma of the rectum. (c) The zone of upward spread involving the pelvic peritoneum, the whole of the pelvic mesocolon and the nodes at the bifurcation of the left common iliac artery.

PROCTOSCOPY AND SIGMOIDOSCOPY

The proctoscope or sigmoidoscope is very useful in examining the sigmoid flexure and rectum in cases of affection of the lower bowel (lesions, polyposis, malignancy, etc.). It may also be useful in revealing the source of hemorrhage. Such causes otherwise are [illegible] determined. The instrument is made up of a rather long metal tube with a balloon [illegible] into which a rounded metal obturator is fitted which facilitates the entrance of the instrument into the bowel (Figs. [illegible]).

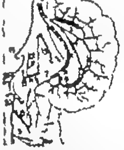


Fig. [illegible]. The blood supply of the sigmoid flexure and rectum. [illegible]

After the sigmoidoscope has been inserted into the bowel, the obturator is withdrawn and the eyepiece, which is equipped with a light bulb and a [illegible] for connection with balloon, is placed in position. The lumen of the bowel is thus effectually illuminated making possible satisfactory examination. The balloon is used to inflate the bowel in cases where it is desired to efface the intestinal folds.

If the patient is extremely nervous, general anesthesia may be administered for this examination. Under usual conditions no anesthetic is necessary.

Much experience is necessary in order to correctly interpret the findings revealed during such examinations and the information gained is most helpful.

LOCAL ANESTHESIA IN OPERATIONS ON THE RECTUM AND ANUS

Direct infiltration anesthesia has many advantages over sacral block (such as change of position of the patient, frequent failure of entering the sacral canal, toxic symptoms, broken needles, etc.).

Begin to inject the anesthetic fluid by marking a wheal near the anal margin and proceed to infiltrate the tissues as shown in Figs. [illegible]. Make sure that no vein is entered during the infiltration (subdermal or deeper). A diamond-shaped, anesthetized zone results. Through this zone introduce the needle at right angles to the skin surface and parallel to the wall of the rectum depositing a wall of infiltration fluid about the lower end of the rectum. With the finger above the internal sphincter muscle as a guide and with the aid of long needles (7 to [illegible] cm. long, [illegible] gauge) excellent anesthesia is usually obtained all around the rectum. Keep the needle constantly moving while the anesthetic

fluid is injected. While the anesthetic should be deposited all around, in the anterior quadrant little solution is required.

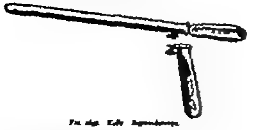


Fig. 1691. Kelly Sigmoidoscope.

AMPUTATION AND RESECTION OF THE RECTUM

Terminology. When the rectum, including its anal portion as well as the rectosphincteric musculature is removed, we speak of an amputation of the rectum.

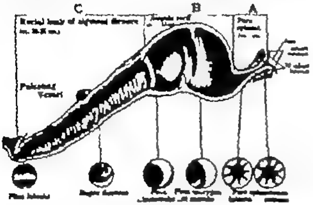


Fig. 1692. Diagrammatic representation of [illegible]. A, B and C, the divisions of the rectum. Below, the [illegible] appearance at various levels of the interior of the intestinal tube.

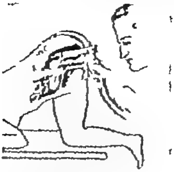
When the sphincters are retained and the continuity of the bowel is restored, resection is spoken of. The methods of procedure in these operations are:

1. Perineal Method.
2. Dorsal Method.
3. Combined Methods.

PERINEAL METHOD

(Lisfranc, Dieffenbach, Lockhart-Mummery)

Step 1. Place the patient in the lithotomy position. General or spinal anesthesia, preferably the latter.



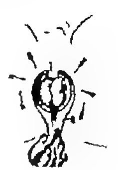


Fig. 1693. [illegible]. Fig. 1694. [illegible]

Fig. 1695. [illegible] Fig. 1696. [illegible]

Step 2. Introduce a catheter into the bladder. Pack the ampulla of the rectum and place a purse-string suture around the anus.

Step 3. Make an incision (Fig. 1698 a, 1, 2, 3, 4) encircling the anus and extending in front along the median raphé of the perineum about the bulb of the

urethra and in the back to the coccyx. Resect the coccyx if more space is needed. Divide the central tendon, the sphincters and fasciae on both sides of the rectum. Expose and divide the levator ani muscles.

Step 4. Doubly ligate and divide the inferior hemorrhoidal arteries. Divide (through the central incision transversely) the connections between the sphincter ani, the transversus perinei and bulbo-cavernosus muscle. Separate the internal sphincter from the levator ani. Pull the anus toward the left side of the patient. Expose the fascia pelvis parietalis by splitting the posterior fibers of the levator ani muscle. Separate the muscular attachments from the coccyx and divide the anococcygeal ligament. Split the pelvic fascia (fascia pelvis parietalis) in the direction of the division of the levator ani. Repeat the procedure on the opposite side. The anal portion of the lower bowel is now considerably freed. Dissection is spread.

Fig. 1697. [illegible]

Step 5. Divide the anterior fibers of the levator ani muscle and the fibrous structures which extend from the rectum toward the bulb and membranous portion of the urethra. Pull the rectum downward. Dissect the bowel sharply, under guidance of the catheter and the finger which palpates the prostate, membranous urethra, seminal vesicles and the urethral bulb.

Step 6. Dissect (bluntly), with the finger, the pelvic portion of bowel (anteriorly). Keep dissecting upward, until the retrovesical reflection of the peritoneum is recognized. Open the rectovesical space. Displace the rectum upward. Dissect (bluntly) between the posterior wall of the rectum and the hollow of sacrum. Ligate and divide the lateral attachments to the rectum carrying the middle hemorrhoidal vessels (not shown in the illustration). Avoid entering the rectum (Fig. 1698 b, 5).

Step 7. Ligate the superior hemorrhoidal vessels running close on the posterior wall of the rectum. Open Douglas space. Pack the protruding small intestines out of the way. Remove accessible fat and enlarged lymph nodes. The rectum must be mobilized sufficiently to permit it being attached firmly to the skin margins without tension.

Step 8. Attend to hemostasis. Remove the packs. Unite the peritoneum to the anterior wall of the rectum with interrupted sutures. (Fig. 1699 a, b.) Clamp and remove the rectum at a distance from the tumor. Ligate all bleeding vessels thoroughly. Obliterate dead spaces. Attach the end of the bowel to the skin edge with interrupted sutures. An alternative method (Fig. 1699 c) consists of suturing the rectum to the fascia at the left of the

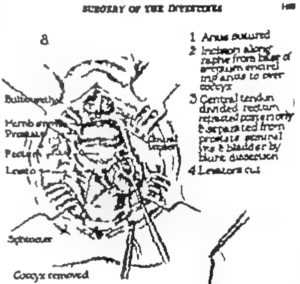


Fig. 1698. Perineal method of amputation of the rectum. Study legends on illustration with steps of operation described in text.

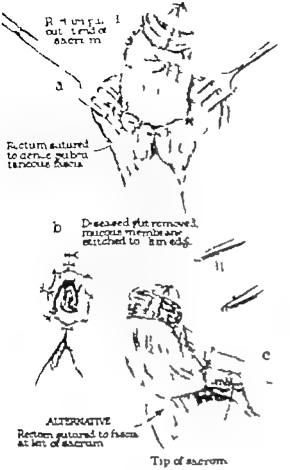


Fig. 1057. Final steps in the perineal method of amputating the rectum. [illegible]

sacrum. In women, the operation is much facilitated by anatomic reasons (short urethra, roomy pelvis).

Difficulties and Dangers. Always mobilize the bowel thoroughly. If the peritoneum is not opened mobilization is difficult, while opening the peritoneum permits effective mobilization. Hemostasis in the depths of the wound is often a difficult matter. Careful dissection and identification of the structures is of paramount importance. In separating the bowel, be gentle and keep close to the rectum. Avoid injury to the blood vessels supplying the segment of bowel remaining by abstaining from rough handling of the tissues. Injury to the blood supply will cause sloughing. Do not permit hemostats to remain attached to blood vessels while proceeding

Fig. 1058. Position of the patient on the operating table for removal of the rectum by the sacral route [illegible]

with the operation. Ligate as you go along. Careful dissection will avoid injury to the bladder, prostate, seminal vesicles, ureters and urethra.

Dorsal Method

(Kraske)

This operation may be performed as a one-stage operation in the form of resection or an amputation (usually an amputation) with the formation of a sacral anus. Many surgeons, including the author, perform a combination two-stage operation. The latter will be described. Occasionally a third-stage operation may become necessary. This is the case when a double-barreled artificial anus is established and the distal short blind segment of bowel remains in the body permanently since it is not possible to remove the sigmoid up to the colostomy by the dorsal route. Usually this section of bowel causes no trouble. However, if it becomes desirable to eliminate it, this may be accomplished at a later date with facility.

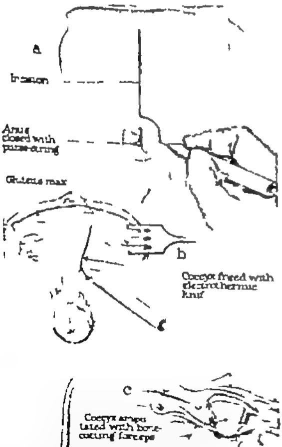


Fig. 1059. Removal of carcinoma of rectum by the dorsal (Kraske) method. [illegible]

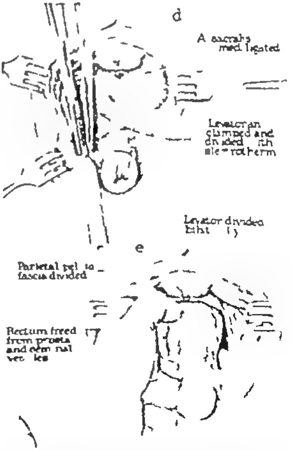
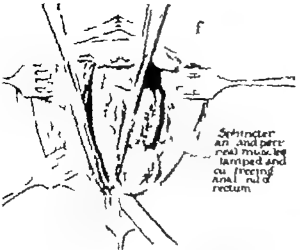
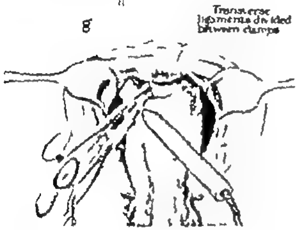


Fig. 1059 (continued). Removal of carcinoma of rectum by the dorsal (Kraske) method. [illegible]





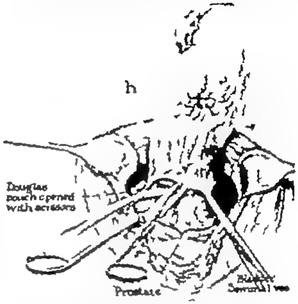
[illegible]

FIRST STAGE

This consists of an abdominal exploration and making [illegible] (see page [illegible])

SECOND STAGE

The second stage of the operation may be performed by sharp dissection or by electrosurgical means. In the latter event the [illegible] is substituted for the scalpel and most of the blood vessels (with the exception of the superior and middle hemorrhoidal vessels) are electrocoagulated instead of ligated [illegible] illustrations and legends for details)



[illegible]

Step [illegible]. [illegible] catheter into the bladder. Leave it there throughout the operation and as long postoperatively as deemed necessary.

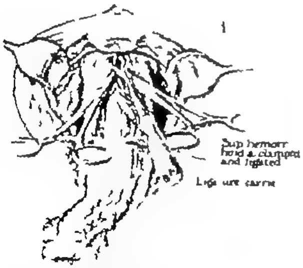
[illegible] Position. This consists of placing the patient on the abdomen with the head lowered, the pelvis elevated and the thighs lowered and separated (Fig. [illegible])

Step 2. Anesthesia. Spinal.

Step 3. Close the anus with purse string suture (Fig. [illegible])

Step 4. The incision surrounds the anus and extends along the coccyx and over the lower part of the sacrum. Separate the [illegible] laterally.

Step 5. Dissect the coccyx and (Fig. [illegible]) the gluteus maximus muscles from their attachments until the [illegible] ligaments appear.

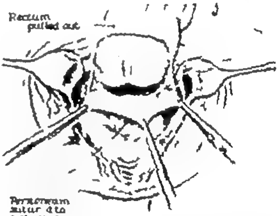


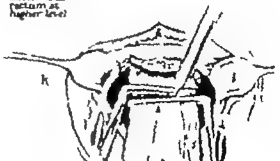
[illegible]

Step 6. The coccyx [illegible] freed from its attachment [illegible] (Fig. [illegible]) and removed. If necessary, one or two lower sacral vertebrae are taken away by means of sharp chisel and hammer.

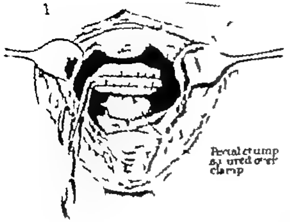
Step 7. Ligate the sacra media artery. If this be difficult, hot pack will usually suffice to arrest the bleeding from this source. If the growth is extensive or the operation threatens to be a difficult one, unilateral division of the sacrosciatic ligament will afford additional space.

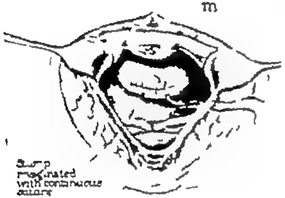
Step 8. Clamp and divide the levator ani and the fascia [illegible] from above downward (Fig. [illegible]) as far from the median line as possible. Extend this incision to the top of the internal sphincter muscle.





[illegible]





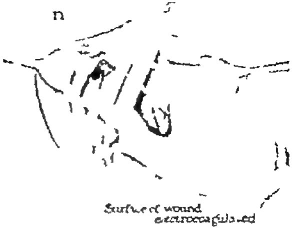


Fig. [illegible] (continued). Removal of carcinoma of rectum by the dorsal (Kraske) method. l. The rectal stump [illegible] sutured over the clamp [illegible]. m. The rectal stump [illegible] invaginated. Over this the suture line [illegible] reinforced by [illegible] interrupted suture line of catgut which may be either continuous or interrupted.

Fig. [illegible] (continued). Removal of carcinoma of rectum by the dorsal (Kraske) method. n. The wound surfaces are electrocoagulated to [illegible] depth of [illegible] mm. o. [illegible]

Step 9. Incise the [illegible] (proper) transversely, joining the two lateral incisions dividing the levator ani muscles (Fig. [illegible]).

Step 10. Choose [illegible] line of cleavage and endeavor to reach the anterior surface of the rectum. Separate [illegible] from the seminal vesicles, prostate and urethra (uterus and vagina in the female). In order to accomplish this the fascia propria must be divided longitudinally. Pull the rectum to one side. Identify in the depth, the natural line of division between the prostate and the rectum. The prostatic plexus of veins is here encountered. In this space (some distal [illegible]) blunt separation of the entire circumference of the rectum is accomplished. The separation is continued upward and downward.

Step 11. A gauze sling is now made to surround the freed portion of the rectum which acts as [illegible] tractor to displace the bowel in the manipulations to follow (not shown in illustrations).

Step 12. The rectum [illegible] now freed from its anterior attachments (posterior wall of the vagina in the female, prostate and seminal vesicles in males).

Step 13. Free the end of the rectum from the sphincter ani and perineal muscles (Fig. [illegible] f). Continue the dissection carefully.

Step 14. Isolate, ligate and divide the transverse fascial bands carrying the middle hemorrhoidal arteries (Fig. [illegible] g). One should pay particular attention to the firm union between the membranous urethra and the rectum. The indwelling catheter [illegible] of help in protecting these structures.

Step 15. Wrap the distal end of the rectum in [illegible] compress. Displace it over the sacrum. On its anterior surface the reflected peritoneum is noted (Fig. [illegible] h).

Step 16. The cul-de-sac of Douglas [illegible] opened. In so doing avoid the ureters.

Step 17. If the carcinoma [illegible] located in [illegible] the freed bowel may now be [illegible]. In most instances, however, [illegible] becomes necessary to bring the bowel farther down. To accomplish this, separate the bowel farther from the anterior wall of the sacrum to about the height of the sacral promontory. Ligate the superior hemorrhoidal artery high up (Fig. [illegible]). This vessel is recognized coursing along the posterior wall of the rectum. Thoroughly remove the lymph nodes and fat along with the vessel. Division of the superior hemorrhoidal artery permits the bowel to further descend for [illegible] considerable distance.

Step 18. Reattach, with interrupted sutures, the peritoneum to the bowel, above the point of proposed division (Fig. [illegible] j).

Step 19. Divide the bowel with the cautery between two right-angled clamps (Fig. [illegible] k).

Step 20. Close the end of the proximal loop of the bowel with [illegible] running catgut suture (Fig. [illegible] l).

Step 21. Invaginate and reinforce the end of the bowel by [illegible] superimposed line of catgut sutures (Fig. [illegible] m).

Step 22. Fulguration. Detect or destroy by electrocoagulation suspicious areas of fat, lymph nodes, etc., in the ischiorectal fossae and wherever encountered (Fig. [illegible] n).

Step 23. Mikulicz tampon (Fig. [illegible] o).

Step 24. Apply voluminous dressings.

Dorsal Resection of Bowel for Carcinoma

This operation is begun and carried out as described in the previous procedure (amputation) until the rectum carrying the tumor is thoroughly mobilized and sufficient tissue is freed above and below the neoplasm to enable the surgeon to join both ends of the bowel after the diseased segment has been removed.

Clamp the segment carrying the neoplasm above and below the tumor. Cleanse (iodine) both ends of the bowel to be joined. Circular end-to-end anastomosis. The sutures (first row) if they be interrupted, must not be tied too tightly in order to avoid circulatory disturbances. The superimposed serous suture is of the Lembert type. Close the soft structures over the anastomosed bowel.

Difficulties and Dangers. Anatomical: Narrow pelvis (male), short mesocolon.

Pathological: Sepsis, hemorrhage, injury to the ureter (especially the left).

COMBINED ABDOMINOPERINEAL OPERATIONS

One stage. Two stage.

Types: (a) abdominosacral, (b) abdominovaginal and (c) abdominoperineal.

ONE-STAGE ABDOMINOPERINEAL OPERATION

Step [illegible]. Anesthesia: Spinal or general. Place the patient in Trendelenburg position.

Step [illegible]. Incision: Left paramedian, from symphysis to above umbilicus (Fig. [illegible] a). Explore. Pack the small intestines out of the pelvis. Explore again thoroughly. Only large bowel should remain in the field of operation.

Step 3. Deliver the sigmoid and rectum and put them on traction. Adhesions are almost always found to exist in the region of the left side of the pelvic mesocolon and the left iliac parietal peritoneum. These should be divided.

Step 4. Incise the parietal peritoneum along the border of the large bowel. Make the incision encircle the rectum at the cul-de-sac of Douglas. Displace the bowel toward the left side.

Step 5. Ligate the superior hemorrhoidal artery [illegible] high above the promontory of the sacrum at the level of the bifurcation of the aorta. The artery should be ligated below the origin of the sigmoid artery [illegible] which is to be carefully preserved because the vessel is to supply that loop of the sigmoid which is to be used for the establishment of [illegible] permanent colostomy.

Step 6. Incise the peritoneal sheath and the mesentery of the rectum on the median side and close to the bowel. This incision is to meet the first one.

Step 7. Separate the bowel, with the hand in the hollow of the sacrum, down to the perineum.

Step 8. Separate the bladder from the rectum, anteriorly.

Step 9. Ligate and divide the middle hemorrhoidal arteries.

Step 10. Pull up the sigmoid and divide [illegible] between clamps with [illegible] cautery at its middle.

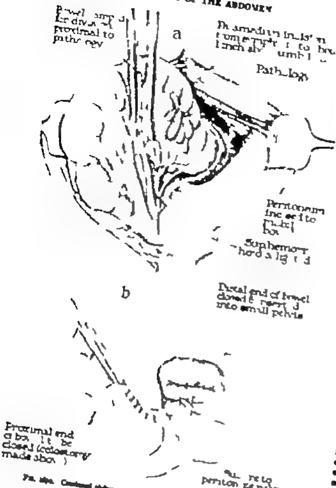


Fig. [illegible]. Combined abdominoperineal resection of rectum. First stage.

Step [illegible] Close the distal end of the bowel with continuous catgut or linen sutures (Fig. [illegible] b)

Step [illegible] Superimpose another purse-string suture and invert the stump.

Step 13 Drop the mobilized segment of rectum into the hollow of the sacrum. Suture the peritoneum over it.

Step 14 The clamped proximal end of the bowel is utilized for [illegible] permanent colostomy.

The permanent colostomy is made through [illegible] stab wound through all the layers of the abdominal wall. Through this opening the proximal end of the divided bowel is passed. It is attached to the skin. The sutures anchoring this end of the bowel should pass through the skin and pick up the taenia longitudinalis.

Step 15 The abdominal wound is closed in the usual manner.

Step 16 The patient is now turned over on the abdomen (reversed Trendelenburg position) and the perineal part of the operation is performed (Fig. [illegible]) The bowel should be thoroughly mobilized by now and freed posteriorly and on each side, the middle hemorrhoidal vessels having been divided with the lateral ligaments.

Step 17 Close the anus with [illegible] purse-string suture.

Step 18 Encircle the anus by an incision which should extend above the sacrococcygeal joint.

Step 19 Remove the coccyx.

Step 20 Divide the levator ani muscles.

Step 21 Incise the fascia propria transversely.

Step 22 Extend the incisions longitudinally along the sides of the rectum and find [illegible] line of cleavage (some [illegible]).

Step 23 Find your way to the hollow of the sacrum. Here the [illegible] and mobilized bowel is found.

Step 24 Separate the bowel from the vagina or seminal vesicles and prostate, respectively.

Step 25 Divide the sphincters (See also Perineal Proctectomy p [illegible] Fig. [illegible])

Step 26 Remove the freed segment of bowel.

Step 27 [illegible] drain.

Two-stage Abdominoperineal Operation

While successful two-stage operations for carcinoma of the rectum show lower mortality than the one-stage procedure, it must not be forgotten, however, that the two-stage procedure carries with it the danger of gangrene of the distal segment of the bowel as [illegible] result of interference with its blood supply (ligation of the superior hemorrhoidal artery) during the period between the first and second steps of the operation. If collateral circulation is adequate, gangrene will, of course, not occur; [illegible] the detached segment is in jeopardy.

FIRST STAGE

Anesthesia. Spinal or General.

The incision is the same as in the previous operation.

Exploration. Establish operability of the tumor (degree of involvement, metastases, encroachment of tumor onto bladder or sacrum, etc.). Isolate the

Fig. [illegible]. Miles' one-stage operation for carcinoma of the rectum. [illegible]

field of operation. Put the bowel and mesosigmoid on tension. Divide the peritoneum on both sides of the mesorectum. At the level of the sacrococcygeal [illegible] across the peritoneum transversely in front of the rectum as low as possible, joining the two longitudinal incisions previously made. [illegible] segment of bowel to be removed. Ligate the superior hemorrhoidal artery. The artery is doubly ligated with silk and divided. The pelvic mesocolon [illegible] is then isolated forward to the edge of the bowel. Any vessels encountered are ligated and divided. The bowel and tumor are thoroughly liberated from the anterior surface of the sacrum. Include in this separation all accessible fat, nodes, etc. Continue the separation downward. Ligate the middle hemorrhoidal vessels, continue freeing the bowel from the seminal vesicles, prostate or vagina, respectively. Great care is to be exercised in the lateral region of the bladder keeping in mind the possibility of injuring the ureters by careless dissection. The dissection [illegible] continued until the anterior surfaces of the levatores ani are reached.

Divide the sigmoid between crushing clamps. The upper segment will serve as [illegible] permanent colostomy. It is brought out through [illegible] incision and the clamp left on the cut end of the bowel for two or three days, after which it is removed and the colostomy opening permitted to function. The lower end is closed by [illegible] continuous catgut suture, the end is inverted and reinforced by superimposed seromuscular suture. The whole is now covered by peritoneum. A tube may be placed under the peritoneal covering. Close the abdomen. After [illegible] fortnight or sooner if deemed advisable, do the

SECOND STAGE

of the operation. This consists in the perineal removal of the lower bowel. The procedure is about the same as the one described under perineal method. It is usually not difficult to deliver the upper end of the closed intestinal portion of the bowel unless adhesions prevent easy access to the tumor mass.

Miles' One-stage Abdominoperineal Radical Operation for Carcinoma of the Rectum*

Step [illegible] High Trendelenburg position. Make an incision about one-quarter inch to the left of the middle line extending from the symphysis pubis to the umbilicus. If necessary in stout individuals, this incision may be extended beyond the umbilicus. Open the sheath of the left rectus abdominis muscle and draw the latter aside. Open the peritoneum to the entire extent of the incision.

* Brit. Jour. of Surgery, Vol. [illegible] No. [illegible] [illegible] October [illegible]

[illegible]

FIG. [illegible] (continued). [illegible]

[illegible]

Step [illegible]. Introduce a self-retaining retractor and retract the edges of the wound widely (Fig. [illegible]). Explore thoroughly to ascertain the presence of palpable lymph nodes. The pelvic mesocolon should particularly be carefully examined for plaques and nodules. If present, these are most commonly found (1) along the parietal border following the course of the superior hemorrhoidal and superior mesenteric vessels, (2) along the margin attached to the colon where the paracolic lymph nodes start and (3) anywhere in the substance of the mesentery itself. When such nodules are present, it is better to look upon the case as inoperable because recurrence is almost certain. Of course, the absence of visible or palpable nodules does not necessarily mean that metastases have not already taken place which are of microscopic size. Nevertheless, even in such circumstances an adequate removal of the mesocolon may still succeed in eradicating the disease. On the other hand, Miles points out, visible spread may exist and the extent of possible extension may not get beyond the area of macroscopic extension to an upward direction. Also, exploration of the liver is not of much value because where macroscopic metastatic deposits of the liver exists, there is almost always obvious extravisceral extension in the pelvis or in the pelvic peritoneum. Observe the position of the malignancy in the bowel wall. If situated in the anterior wall of the bowel, particular attention should be paid to possible involvement of the bladder in the male or of the posterior wall of the vagina in the female. In such instances, Miles considers the case as inoperable because where the bladder is involved it is impossible to remove the growth completely and if the vagina is the seat of involvement, the additional removal of the uterus and posterior wall of the vagina is too much for the patient to endure. Miles has resorted to such procedure in three cases and all three patients died. The pelvic cavity must be freed from small intestines. Difficulty arises in the operation sometimes by reason of the presence of the small intestines. All of the small intestine is pulled out through the incision and is permitted to hang down outside of the abdomen after being covered by a Cryps abdominal towel wrung out of warm salt solution which should be changed frequently to keep the intestine moist. Miles says "I have done this on a great many occasions and I can confidently say I have never seen any harm result therefrom either from the intestines being temperature or from its becoming temporarily congested on account of its position."

Step 3. The Pelvic Operation. Deliver the colon through the abdominal wound and note the position of the blood vessels. Sometimes some difficulty is experienced in doing this, because of peritoneal bands of adhesions which, when present, should be freely divided on the outer side of the pelvic mesocolon, thus mobilizing the pelvic colon and permitting its proximal portion to be later utilized in the formation of the colostomy without too much tension. Select the point in the bowel between the anastomotic loops of the first and second sigmoidal branches of the inferior mesenteric artery. Apply to this point an intestinal crushing clamp which is left on for a couple of minutes. In most individuals the exact distribution of blood vessels in the mesocolon may at times be difficult in which case it is much safer to

FIG. [illegible] (continued). [illegible]

[illegible] (Reproduced from The British Journal of Surgery.)

apply the clamp a little nearer the middle of the loop than elsewhere (Fig. [illegible]).

Step 4. Remove the clamp. A crushed area of bowel corresponding to which to that of the blade of the clamp is now observed. A clamp, the blade of which is about one inch wide, is used. The crushed ribbon of intestine affords sufficient room for dividing the crushed part of the bowel between two ligatures properly placed (Fig. [illegible]).

Pass a stout ligature through the mesocolon at each extremity of the crushed area and ligate it tightly. This occludes firmly the lumen of the bowel in two places. Divide the bowel with scissors in such a manner that the cut extends into the crushed portion of the mesocolon. Invaginate the ligated ends of the bowel with a purse string suture, the attachment of the mesocolon to the bowel having been first divided for a short distance close to and parallel with the bowel, thus rendering the invagination easier. The distal end of the bowel should be carefully closed to prevent the possible escape of intestinal contents during the subsequent manipulations.

Step 5. Make an incision through the peritoneum on the outer aspect of the pelvic mesocolon at the level of the left sacro-iliac synchondrosis along its parietal border. Define the left ureter through this incision as it crosses the left common iliac artery (Fig. [illegible]). Here the ureter lies parallel to and in close contact with the inferior mesenteric vessels and if not carefully drawn aside may be included in the ligature applied to the vessels at this point. Ligate the inferior mesenteric artery at a point immediately below the origin of the first sigmoidal branch. Occasionally the second sigmoidal artery arises from a common trunk with the first. In such event the ligature must be placed below the common trunk and the second sigmoidal artery must be ligated separately when the mesentery is divided. Divide the remainder of the pelvic mesocolon, the inferior mesenteric vessels as they lie at its parietal border below the point of ligation. After all bleeding vessels in the proximal portion of the pelvic mesocolon have been carefully ligated the proximal end of the bowel is temporarily dropped into the abdominal cavity.

Step 6. Make an incision beginning at the point where the pelvic mesocolon has been divided on either side of the attachment of the lower portion of the pelvic mesocolon at a distance of about one inch from it. Carry these incisions down into the pelvis running parallel to the mesocolon to the level of the peritoneal reflection. The reason for making these incisions about one inch away from the attachment of the mesocolon is "because the lymphatic vessels which accompany the superior hemorrhoidal vessels extend a little beneath the peritoneum on either side. Miles observed on several occasions plaques of growth in one or the other side of the line of attachment to the mesocolon. Have an assistant draw forward the distal portion of the pelvic colon and open up the connective tissue space in front of the concavity of the sacrum. Insert the fingers of the left hand into this space and detach from the ligamentous structure in front of the sacrum the pelvic mesocolon with its blood vessels and lymph nodes as well as the rectum surrounded by its fascia propria (Fig. [illegible]). The detachment of these structures is easily accomplished. Care, however should be exercised not to injure the

[illegible] sacral vessels [illegible] run along the midline of the anterior surface of the sacrum. Continue the separation of the rectum from the hollow of the sacrum down to the level of the sacrococcygeal articulation. This point can be readily recognized because the fascia propria recti is firmly adherent to the last segment of the sacrum and offers resistance to being stripped from it.

Step 7. Carry forward the incisions in the peritoneum previously made on either side of the pelvis and have them meet anteriorly behind the base of the bladder in the male or in the upper portion of the vagina in the female. It should be remembered that the ureters skirt the lateral [illegible] of the pelvis in their course to the bladder; thus extra caution is necessary not to injure them. Continue the separation of the anterior wall of the rectum by means of blunt dissection. In the male the rectum must be separated from the bladder and seminal vesicles as far as the upper border of the prostate gland. This step requires great caution lest the seminal vesicles or vas deferens be injured. It is also of utmost importance that the separation of the rectum be carried down to the prostate. If this step is not carefully carried out much difficulty will be experienced during the perineal portion of the operation. Separation of the rectum from the vagina is usually easy and need only be carried half way down the posterior wall.

Step 8. Continue the isolation of the rectum from the lateral attachments first on the left and then on the right side. While so doing on the left side, constant vigilance is necessary not to injure the ureter because of its close position to the rectum on that side, [illegible] on the right the ureter is somewhat distant from the rectum and need not be included at its attachment to the parietal peritoneum. The presence of the lateral ligaments of the rectum have render this step of the operation—the isolation of the rectum—the most difficult (Fig. [illegible]) because of the stout structure of these [illegible] developed vertically connective tissue bands composing the ligaments and unless these are completely and thoroughly divided on both sides of the rectum as far as the [illegible], the surgeon will be confronted with much difficulty in withdrawing the rectum through the perineal wound. Miles emphasizes the importance of this step, stressing that the incomplete division of these lateral ligaments during the abdominal part of the operation renders the perineal portion unnecessarily tedious and prolonged. The middle hemorrhoidal arteries run in the substance of the lateral ligaments; they must be ligated and divided.

Step 9. Push all of the isolated portion of the bowel down into the pelvic cavity. Re-establish the floor of the pelvis by properly suturing the peritoneum. "On no account," says Miles, "should the pelvic mesocolon be left in situ with [illegible] view to facilitating the closure of this gap because this is directly in line with the upward spread and is, therefore, to be considered highly dangerous tissue. I cannot emphasize too strongly the necessity for completely removing this structure in every case together with [illegible] wide strip of the adjacent peritoneum if immunity from recurrence is to be hoped for." Dissect up freely the peritoneum from the lateral walls of the pelvis. In so doing, avoid injury to the ureters. Generally the posterior margins of the peritoneum can be brought together in front of the promontory of the

sacrum without excessive tension. These should be sutured to the pelvic mesocolon at the point where the inferior mesenteric vessels have been ligated. A large pear shaped gap will remain to be closed, the lateral margins of which cannot possibly be approximated. The gaps should be closed as follows: (1) In the male: Dissect up [illegible] flap of peritoneum from the bladder and stretch it backwards across the gap and suture it there (Fig. [illegible]). In the female: Dissect up the innermost layers of the broad ligaments and utilize them to peritonealize the remaining gap. Particular attention should be paid that peritonealization is carried out thoroughly. Miles has [illegible] from intestinal obstruction in which [illegible] loop of bowel became incarcerated through [illegible] small hole between the sutures in [illegible] delicate peritoneum. To reinforce the suture an omental graft may be used.

Step 10. Do [illegible] colostomy by using the proximal end of the pelvic colon at [illegible] point about one and one half inches internally to the left of the anterior superior spinous process of the ilium along [illegible] line extending from that process to the umbilicus. Make [illegible] short incision through the skin and subcutaneous tissues about one and one half inches long with its center intersecting the line above alluded to at right angles. Divide now the aponeurosis of the external oblique muscle for about one inch. Separate bluntly the muscular fibers of the internal oblique and transversalis muscles in the direction of their fibers. Create an opening through the transversalis fascia and peritoneum just large enough to admit the finger through which draw up the stump of the proximal end of the pelvic colon and fix it in position at the upper and lower angles of the wound by means of silk worm gut sutures (Fig. [illegible]).

Step [illegible]. Attend to the toilet of the peritoneum. Close the abdominal wall in the usual manner. Apply dressings. Lower the patient from the Trendelenburg position and turn him into the right dorsal and semi-prone position.

Step 12. The perineal portion of the operation. Close the anus by [illegible] purse string suture. Make [illegible] transverse incision about four inches long at the level of the sacrococcygeal articulation. Make [illegible] long incision from the center of the transverse cut running in the furrow between the nates and carried down to [illegible] point one inch from the posterior portion of the anus. Carry incisions from the inferior extremity of this incision to the right and left in [illegible] the anterior extremities of which are joined by [illegible] transverse cut (Fig. [illegible]). Miles stresses the importance of the area of the boundary incision embracing as wide an area of perineal tissue as possible because of the vulnerability of the skin in this region to recurrence. Retract the skin flaps and expose the coccyx.

Step 13. Open the sacrococcygeal joint and dissect out the coccyx. Deepen the incision surrounding the anus so as to include all of the ischiorectal fat (Fig. [illegible]). The removal of the coccyx alone suffices to afford ample room for the completion of the operation. Miles states that sufficient room is afforded without even removing the coccyx but he cautioned its removal in view of the fact that the coccygeal muscles must be removed and the coccyx would be left without lateral support.

Step 14. Make [illegible] small transverse incision into the dense connective tissue immediately below the sacrum. Detach from the ventral aspect of the lower-

most piece of the sacrum the attachment of the fascia propria of the rectum. Introduce the index finger into the opening thus created and find the space containing the isolated bowel, provided the latter has been sufficiently detached as indicated above. Make [illegible] transverse incision through the coccygeus muscles on either side. This incision should extend outwards as far as the sacrosciatic ligaments. Through the space thus resulting the isolated bowel is drawn down to its full extent (Fig. [illegible]) exposing the base of the bladder, the seminal vesicles with their seminal ducts, to the upper part of the prostate in the male and the uterus and upper half of the posterior vaginal wall in the female.

Step 15. Traction is made with the left hand upon the bowel putting the levatores ani on the stretch, if they do not readily come to view [illegible] because the lateral ligaments of the rectum have not been completely divided from above. In such case difficulties present themselves in delivering the detached bowel through the perineal wound until the lateral ligaments of the rectum are completely divided (the levatores ani cannot be successfully dealt with). Divide the levatores ani at their origin from the lateral wall of the pelvis, detach the puboprostatic fibers from the prostate. In cases where the neoplasm is situated on the anterior wall of the ampulla of the rectum, Miles makes the practice of dissecting away the prostatic capsule as well.

Step 16. Detach the anterior wall of the anal canal from the tissues forming the central point of the perineum avoiding, while doing so, injuring the membranous portion of the urethra.

Step 17. The resulting large cavity will heal gradually by granulation. Only portions of the skin incision are brought together by sutures. Pack the cavity [illegible] strips of gauze to support the new pelvic floor formed only by peritoneum. Avoid having the gauze come in direct contact with the walls of the cavity to circumvent pain during its removal. Miles uses [illegible] sheet of gauze protective about two feet square to line the cavity and then packs gauze into [illegible] (Fig. [illegible]). Apply voluminous dressings. Turn the patient on his back. Dress the abdominal wound. Before the patient is removed from the operating table the ligatures closing the stump of the proximal end of the pelvic colon are removed and the open end of the bowel is covered with gauze protective and [illegible] pad of gauze.

Bartlett: One Stage Operation

The Bartletts (Willard and Willard Jr.) describe [illegible] one-stage combined resection of the rectum[1] which they summarize as follows:

Regional spinal anesthesia may be used in this method. By liberating the rectum and anus and bringing them, enclosed in [illegible] rubber bag, out of the abdominal wound to be used as tractor because the most difficult part of the operation, deep pelvic dissection [illegible] much simplified, since the mesocolon is thrown into relief and put on the stretch (Fig. [illegible]). It is infinitely easier to work from the depths toward outside than in the opposite direction. Higher division of the vessels may be carried out, and the superior hemorrhoidal is cut [illegible] safe point. The posterior attack is shortened, there are no drains or other gauze here and there is no risk of [illegible] blow-out before the peritoneal closure. One

[1] Annals of Surgery, Vol. [illegible], pp. [illegible], May, [illegible]

may perform [illegible] preliminary colostomy for exploration, for relief from obstruction, for washing out the bowel and to enable one to leave the clamp on the intestine satisfactorily after resection. With the fecal fistula made in the right upper quadrant, one can perform an adequate exploration and at [illegible] subsequent operation [illegible] in an abdominal wall and pelvis undisturbed by previous manipulations.

Jones wrote of the abdominoperineal operation: "The chief objection to the operation, the length and difficulty of it in some cases, must be admitted, and

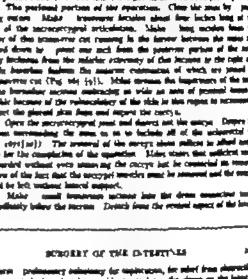


Fig. [illegible]. Operation completed from below. Remains ensued with rubber. (Courtesy Dr. Willard Bartlett.)

only those who are willing to accept these conditions as part of the operation should undertake [illegible]. If, as we believe, the operation here presented advances us further along any of the lines fundamental to ideal operations, [illegible] will make sound principle available to practice in the hands of a larger number of surgeons than formerly."

Comment: What operation should be selected in the treatment of carcinoma of the rectum? Disagreement is dangerous. The surgeon should have at his command [illegible] number of procedures among [illegible] those particular ones.

In regard to the actual surgical treatment of carcinoma of the rectum, much progress has been witnessed during the past decade. At the present

tone radical extirpations of the rectum and involved tissues, either by the abdominoperineal or abdominosacral routes, are the procedures of choice and as stated, in early diagnosed small and accessible cases, electrocoagulation alone may suffice. Either method may be carried out by scalpel surgery or electrosurgery) but in the treatment of this malignant condition electrosurgery, in certain cases, is coming gradually but steadily to the foreground under the stimulus of Kelacher, Schmieden, Westhues, Mandl, Rosman, Goetz and others. These operations may be carried out in one or two stages.

Conclusions. From available statistical data, abdominoperineal resection or amputation in one stage still shows a distressingly high operative mortality

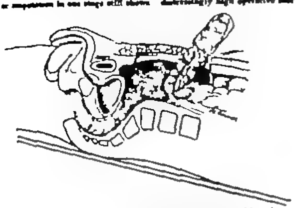


Fig. 1698. Patient in ... position. Specimen delivered through abdominal incision and ... Courtesy Dr. ...

tality in average hands with the exception of the reports in the hands of some surgeons (Miles, Rankin, Jones, Bartlett, and others). While graded abdominoperineal resections (Rankin) are, at the times, the procedures of choice, the one stage operation is gaining favor. In fact, Rankin recently lauded Miles' one-stage abdominoperineal resection as best. H. B. Devine* is constantly in favor of first "defunctioning" the large bowel by special transverse colostomy followed later by the resection of the affected segment of "defunctioned" bowel coupled with an end-to-end anastomosis or in selected cases by telescopic rectosigmoid anastomosis or complete ablation of the distal segment of the bowel.

Some are consistent partisans, as is the author, for attacking certain cases of rectal malignant disease by the combined abdominosacral route, or abdominoperineal operations, others have adopted many stage procedures

* Devine, H. B.: ... Jour. of Surg., July ... and Jan. ... British Med. Jour., Dec. ... Med. Press and Circ., ... Vol. CXC ...

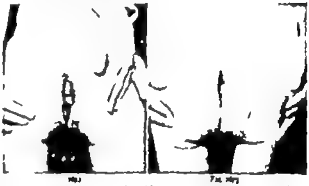
as conservative and satisfying. The operative mortality of the one stage abdominoperineal operation in most hands today is much higher than in graded operations.

Therefore, only surgeons of extraordinary experience in that particular field should resort to the Miles' procedure while those whose experience is that of the average well trained general surgeon, will serve the interests of the patient best by resorting to less exacting undertakings and limit their operations to the procedures described in this chapter taking advantage of the graded operations of Rankin, or perhaps, if conversant with the technic, of Devine.

Fig. 1697. Papillary adenocarcinoma of rectum. Removed by electrosurgical technic.

Well planned, graded electrosurgery often promises gratifying results (Fig. 1697). In the first stage of the operation electrocoagulation of the accessible neoplasm and local sterilization are effected. The chances of infection at subsequent steps of proctectomy are thus minimized. This procedure in itself may suffice in rectal carcinoma of the ampulla, if not advanced. If the latter be the case, it may be a means of palliation. This is followed by colostomy.

The dangers incident to the final stage of the operation (dorsal amputation by electrosurgical means) are also reduced for the following reasons



1693 Fig. 1695

Fig. 1693. Recurrent carcinoma after classical ... operation, ... by electrocoagulation. ... Fig. 1695. Patient ... days after electrocoagulation of ...

Electrosurgery definitely reduces immediate operative mortality. Local implantations and metastases are often frustrated.

3. Carcinomatous masses that cannot be removed with the scalpel can often be attacked with facility by electrosurgical means. (Figs. 1694-1695-1696.)

It is the unanimous experience of surgeons operating with the aid of electrosurgery that their patients are surprisingly free from postoperative shock and pain. Dominik Kulenkampff has shown that the transmission of pain impulses are prevented by the aforementioned capping of nerves resulting from the division by the diathermy current. Kelacher (1930) pointed out that the coagulation effected by diathermy not only produces mechanical destruction of the malignant mass but that certain substances and antibodies are thrown off into the circulation which tend to immunize the patients against further progress of the disease and in many instances an arrest of the growth of malignant cells results from the point of diathermy destruction is observed. This may be attributed to an intense stimulation of the reticulo-endothelial system and its consequent local and general phagocytic action of the macrophages.

Fig. 1696. Colostomy ... of ... Specimen removed ... days after operation.

The postulate of Mandl, that the destruction of the lateral chain of lymph nodes including fat, fascia, etc., harboring malignant cells in ... cases ... can certainly be better accomplished with by electrosurgical means than with the scalpel.

IMPERFORATE ANUS

There are two types of imperforate anus: (1) no anal depression is present (2) an anal depression is present but does not open into the rectum. Anywhere the following. In the defect located in the anal canal. Does ... involve the lower rectum or does ... extend even higher? Occasionally there ... an apparent opening at the anus but higher up ... membranous diaphragm prevents the feces from passing down. In either event the point is not to wait but to afford an opening for bowel evacuations.

Anal Portion of the Bowel Is Present but Is Not Joined to the Rectum

Step ... By palpation and inspection find if there is only ... thin diaphragm separating the rectum from the anal canal. (Fig. 1697.)

Step ... Excise or perforate the diaphragm.

After-care. Resort to digital dilatations.

Much Tissue Is Interposed (Fig. 1698)

Make an incision in the midline from the anal depression to the coccyx. Deepen the incision as indicated and proceed as if no anal opening were present (see below) except that after the rectum has been opened and evacuated, suture the margins of that opening to the anal gut instead of the skin.

In days past, ... trocar and cannula were used to establish an opening. This procedure ... to be condemned. Fatalities resulted from it (peritonitis, opening of the bladder, injury to large pelvic blood vessels, etc.).

No Anal Depression Is Present (Fig. 1699)

Step ... Make an incision in the median line from the scrotum or fourchette to the tip of the coccyx, carried down to the floor of the pelvis. The incision may be extended later if necessary. If the bowel is not found, retract the

Fig. 1697 Fig. 1698 Fig. 1699

Fig. 1697. Imperforate anus and rectum. Type I. Observe ... the cavity ... formed ... between the anus and rectum. ... Bladder ... Sph. sphincter.

... 1698. Imperforate anus and rectum. Type II. Much tissue ... interposed.

Fig. 1699. Imperforate anus and rectum. Type II. Observe here the lower portion of the rectum ... absent (after ...)

walls of the wound ... search for the bowel by blunt dissection, excising the coccyx ... and lower segment of the sacrum, if necessary. When found the lower end of the bowel should be freed as much as possible from its surroundings.

Step 2. If the bowel is found situated superficially it should be seized ... forceps and pulled down, separating any lateral attachments.

Step 3. Incise the bowel. Clean out its contents by injections of warm water and some mild antiseptic solution. The opening in the bowel is then sutured to the skin with interrupted sutures and the rest of the skin opening closed (Fig. 1699) (Amussat ... operation).

Comment. When the bowel is deeply situated it will be more difficult to pull it down without first evacuating its contents and separating it clearly from its lateral connections. In carrying on the dissection, concentrate the work to the hollow of the sacrum instead of in the front (injury to genito-urinary organs). When the bowel has ... should be made to suture it to the skin before

is not always possible. When every attempt to bring the bowel down fails, do [illegible] colostomy.

Anus Is Absent. Rectum Opens into the Vagina

Be in no hurry to operate. Such condition is entirely compatible with life provided, however, that sufficient room is present for the feces to satisfactorily discharge from the vagina. Cases are of record where women with such congenital defects married, have children and carried on normally. Sir Charles Ball (quoted by Lockhart-Mummery) reported a case of a woman whose rectum

Fig. [illegible]. [illegible] apparatus for [illegible] (after [illegible]). The sphincter [illegible] [illegible]. The [illegible] is [illegible] [illegible] with [illegible] pattern.

Fig. [illegible]. Method of dilating the sphincter. [illegible] [illegible] the sphincter. The [illegible] [illegible] dilatation of the sphincter [illegible] obtained.

opened into the vagina: she suffered no inconvenience from the abnormality and was the mother of six children. If an operation is later decided upon some form of plastic procedure may be resorted to.

Rectum Communicates with Bladder or Urethra

This condition is incompatible with life. Operate at once. Establish perineal opening.

Comment. Prompt diagnosis and proper course of treatment are essential here. M. Kennison pointed out, as far back as [illegible], that in the great majority of cases of this type there exists in the perineum [illegible] sphincter apparatus. The practical conclusion here is that it is not essential, where difficulties present, to bring the end of the bowel down to the anus; if placed somewhat behind the anus it will work equally well. In separating [illegible] bands, remember these often carry the nutrient vessels to the [illegible] segment of bowel. Where space for work is needed, open the peritoneum. Work with deliberation and thoroughness.

FISSURE OF THE ANUS

Divulsion

Local anesthesia. Figure [illegible] illustrates the technic of digital divulsion. Observe the position and direction of force of the dilating thumbs.

STEP METHOD

Step 1. Place the patient in the lithotomy position.

Step [illegible]. Introduce the left thumb which has been well oiled into the anus. Dilate the sphincter by exerting pressure toward the posterior commissure.

Step 3. Introduce the other thumb into the rectum also, and dilate and divulse the sphincter with both thumbs.

Step 4. Excise the fissure completely. Do not cut too deeply (injury to sphincter). Pack with iodoform gauze.

Dangers. Great care should be exercised to avoid injuring the [illegible]. Do not overstretch; this may result in temporary or permanent [illegible]

Fig. [illegible]. Dumbbell-shaped [illegible] abscess.

[illegible]. Be careful not to rupture any muscular fibers; hemorrhage into the muscular tissue may ensue which is likely to be followed by [illegible] of the blood and connective tissue thus destroying the muscular fibers.

ISCHIORECTAL ABSCESS

Anatomic Considerations. In this condition, the presence of the blood vessels, nerves and loose cellular tissue running through the cavity is noted. The ischiorectal fossa is formed in the shape of a triangle, the apex being formed by the junction of the obturator fascia with the lower fascia of the levator muscle, [illegible]. If an abscess which has formed in this region is not treated surgically, [illegible] emerges between the two sphincters in the posterior commissure. On some occasions it opens through the levator ani and then through the rectum.

It should be borne in mind that there may be numerous small abscesses which must be opened. This is done with the gloved finger after the incision has been made. The experienced surgeon can readily distinguish between healthy and necrotic tissue and is careful to destroy only that which is diseased. The destruction of tissue and the rupturing of blood vessels are to be avoided in order to avoid infection of the adjoining parts. Matters become more complicated when both ischiorectal fossae are involved (Figs. [illegible]). In these cases [illegible] advocates opening both abscesses at [illegible] point where they meet which, as [illegible] rule, is at the apex of the triangular space. He introduces drainage tubes into both abscess cavities. This procedure does not seem to have great deal of merit and it would seem preferable to drain both abscesses separately

[illegible] at the same time. The fistula which often follows should be treated at a later date. Patients suffering from this infection are usually markedly septic and the sooner the pus is evacuated the sooner recovery will take place.

Dangers and Difficulties. It is [illegible] simple matter to open an ischiorectal abscess. The chief danger lies in damaging the branches of the long pudendal nerve and in spreading the infection by opening into healthy tissues.

In most cases, failure to cure an ischiorectal abscess is due to improper drainage and to leaving the drainage tube in place so long that it forms [illegible] fistula. Disappointment due to incorrect treatment happens frequently. To avoid mishaps, the surgeon must also keep in mind the communicating nature of the tract and that the abscess may have broken high in the region of the rectum and that the opening is often in the posterior commissure and is quite small. Careful search should be made for any opening in the rectum above, including to recognize it as likely to result in failure.

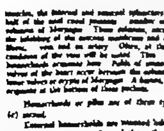


Fig. [illegible]. Dumbbell-shaped ischiorectal abscess. Incision has been made over fluctuating area.

HEMORRHOIDS

Anatomic Points. The anal canal [illegible] slit-like opening by which the rectum communicates with the exterior. It extends from the levator ani to the skin. The lower half of the canal [illegible] lined with squamous epithelium. It [illegible] [illegible], that [illegible] and [illegible] protected by two muscles, the internal and external sphincters. The mucous membrane of the lower half of the anal canal presents [illegible] number of vertical folds which are known as the columns of Morgagni. These columns, according to [illegible], are formed by the infolding of the mucous membrane and contain in their interior some muscular fibers, [illegible] vein and an artery. Often, at the lower end of the columns [illegible] varicose condition of the vein will be noted. This [illegible] known as the hemorrhoidal zone; most hemorrhoids originate here. Folds of mucous membrane resembling the semilunar valves of the heart occur between the columns. These are referred to as the semilunar valves or crypts of Morgagni. A fissure, an abscess, an ulceration or [illegible] fistula may originate at the bottom of these pockets.

Hemorrhoids or piles are of three types: (a) external, (b) internal and (c) mixed.

External hemorrhoids are situated below the external sphincter muscle. Internal hemorrhoids are situated above the sphincter muscle. [illegible] mixed hemorrhoids are partly within and partly without the anorectal canal and are covered by both mucosa and skin. Ideally each type requires its own method of surgical removal, but generally speaking, uncomplicated external and internal hemorrhoids are usually treated either by clamp and cautery or excision and suture. For maximum degrees, one of the varieties of the Whitehead operation is em-

ployed. This consists of [illegible] circular excision of the entire pile-bearing area followed by the necessary ligation of vascular parts and the complete closure of the [illegible] wound by suture. The Whitehead operation is usually reserved for cases in which the pile-bearing area affects [illegible] considerable segment of [illegible] membrane of the bowel and when there is much prolapse of the piles.

Ligature and Suture Operations

Historical Notes. Celsus recommended the use of [illegible] strong flax thread used to traverse the base of the tumor by means of a needle; the ligature was then tied at each side, and the tumor permitted to slough off. In [illegible] the ligature operation was quite popular with French surgeons, but later, owing to some accidents, it lost the popularity.

Excision alone was practiced by such men as Hippocrates, Galen, Celsus, Aetius, Albucasis, [illegible] and others. From this we can see that very little change has taken place since the time of Hippocrates, and that the operations, as then practiced, are still in vogue with slight modifications.

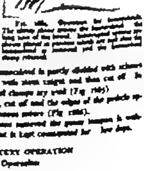


Fig. [illegible]. Operation for hemorrhoids. [illegible]

The general operative procedure of the ligature operation for ordinary hemorrhoids is as follows:

Step [illegible]. The patient is placed in the extreme lithotomy position and the orifice of the anus is thoroughly dilated until it becomes open and is easy of access. The rectum is washed out and packed with gauze.

Step 2. The hemorrhoids are easily seen and each one is grasped with forceps (Fig. [illegible]). The mucous membrane of the pedicle of each hemorrhoid is partly divided with scissors or scalpel; the hemorrhoid ligated with stout catgut and then cut off. In the case of large hemorrhoids special clamps are used (Fig. [illegible]).

Or the hemorrhoid is clamped, cut off and the edges of the pedicle approximated by interrupted or continuous suture (Fig. [illegible]).

Step 3. When all hemorrhoids have been removed the gauze tampon is withdrawn from the rectum. The patient is kept constipated for [illegible] few days.

CLAMP AND CAUTERY OPERATION

Cantoni Operation

Step 1. Place the patient in the lithotomy position.

Step 2. Grasp the hemorrhoid with [illegible] forceps. Cut off the skin tabs even with the skin to prevent edema.

Step 3. Place [illegible] clamp with the heel directed toward the outer part of the hemorrhoidal tumor. Remove the forceps and excise the pile about [illegible]

back from the clamp leaving a stump which is now thoroughly cauterized (Figs. 1667, 1668).

Step 4. Release the clamp gradually and see that the stump is not bleeding as it resumes the tissue. Apply the same procedure to the other hemorrhoids.

Step 5. Insert into the rectum a small bolster which has been covered with sterile vaseline; place over this some fluffed gauze.

Fig. 1669. Hemorrhoidal Clamp.

Step 6. With the patient in proper position strap the buttocks with adhesive plaster. Permit the end of the wick to project between the pieces of adhesive plaster. Administer ¼ gr. morphine to the patient before he comes out of the anesthetic. Remove the pack after twenty four hours. Constipate the patient for 72 hours. At the end of this period give an oil enema and follow with a cathartic.

ELECTROCOAGULATION OF HEMORRHOIDS

Position the patient. Local anesthesia. Dilate the sphincter and bring down the hemorrhoids in a pile clamp. Apply a clamp to the base of the hemorrhoids. Grasp the hemorrhoid with a pair of forceps. Touch the forceps with the diathermy needle. The change in color of the pile will indicate the degree of coagulation obtained. Avoid coagulating too deeply. A ligature may now be applied to the base of the hemorrhoid as shown in the illustration.

The destroyed pile usually sloughs off about the tenth or twelfth day. The base is represented by a clean granulating wound which heals with a soft pliable scar not tending to stricture formation. Pain is minimal. The results from this method are very gratifying.

After-care. Rectal tubes should be omitted. I believe these should be reserved for "one" occasion. (Bacon.) It is a safe precaution to keep the bowels locked up for a few days. Do not permit rectal tags to remain. Patients look upon these as hemorrhoids and often seek their removal, although they give rise to no trouble other than their presence.

WHITEHEAD OPERATION

This procedure is indicated in cases of marked prolapse of the hemorrhoids or an excess of mucous membrane. On account of the uncertainty of primary union, hemorrhage, complicated technic and the formation of a stricture following the operation this method is not a favorite among many surgeons. In skilled hands it has been known to often give more satisfactory results than any other method in certain cases. If the mucous membrane is properly approximated and proper postoperative treatment given, strictures should be avoided.

Particular attention should be given to preparing the patient for this operation: the lower bowel should be cleansed thoroughly to avoid soiling the wound during the operation, which would prevent primary union.

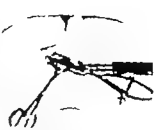


Fig. 1686. Hemorrhoidectomy. After removing the hemorrhoid the drained base may be sutured as shown in the illustration. (After Lockhart.)

Fig. 1687. Crutch, clamp and cautery operation. Small hemorrhoid removed with light electrocautery.

Step 1. Make an incision in the posterior commissure between the mucous membrane and the skin. Introduce a scissors through this wound and separate the mucous membrane from the adjacent tissue.

Fig. 1688. Crutch, clamp and cautery operation for hemorrhoids. Hemorrhoidectomy.

Step 2. Continue the posterior incision on both sides up to the anterior commissure where the mucous membrane closely adheres to the muscular wall of the bowel (Fig. 1689). It is advantageous to leave this attachment outside as it acts as a fixed point holding the mucous membrane in case the suture does not hold, and in case of infection occurring anteriorly it prevents the involvement of the pubovesical space.

Step 3. With T-forceps, grasp the cuff of mucous membrane; dissect it up with scissors until healthy mucous membrane is reached; detach the region bearing the hemorrhoids from the muscular wall of the rectum.

Step 4. Make a longitudinal incision in the mucous membrane extending from the mucocutaneous margin to a point where the mucous membrane is healthy

(Fig. 1690). Each flap thus formed is grasped with T-clamps and the mucous membrane carrying the hemorrhoids is brought down and held by an assistant.

Step 5. Make a transverse incision in the mucous membrane above the hemorrhoidal region. After each incision, suture the mucous membrane, little by little, to the edge of the mucocutaneous surface as the hemorrhoidal area is being cut off step by step. (Fig. 1690.)

Control hemorrhage from the blood vessels which have been sutured with interrupted sutures.

FISTULA IN ANO

Fig. 1692. Whitehead's operation for removal of hemorrhoids. Ends of mucous membrane are drawn up and held by the aid of forceps. The dotted lines at the edge indicate the margin of the sphincter muscle. The dotted lines show the line of incision.

Fistulas may be divided into complete and incomplete. Incomplete fistulas may be external, internal, deep or superficial. Complete fistulas are those where there is a communication between the bowel and the skin surface, or between the bowel and some adjacent organ. (Fig. 1692.)

Anatomic Points. The location of the external opening of the fistula may to a certain extent, be of great assistance to the surgeon in locating the internal opening and deciding on the method of treatment. If the external opening is within 1½ in. of the anus, and anterior to a line drawn from one tuberosity to the other, the fistulous tract is generally straight and the internal opening will be found anteriorly and close to the external sphincter. If the external opening is within 1½ in. of the anus and posterior to this line, we may expect to find the internal opening in the posterior commissure between the sphincters. There are exceptions, but these only "prove the rule." (Lynch.)

In 1921 Jerome Lynch described his method of determination of the fistulous tract with peroxide of hydrogen and methylene blue. I found this an excellent method for determining the extent and location of the fistulous tract.

Operations on Anal Fistula

Anesthesia. Local or general anesthesia may be used for fistula operations. When it is necessary to obtain thorough relaxation of the anal sphincter use spinal or sacral anesthesia. Complete excision may often be done (Fig. 1693).

Fistulotomy or Division of the Fistula

Step 1. The patient is placed in the lithotomy position and the field of operation carefully prepared.

Step 2. Dilate the sphincter ani.

Step 3. Examine for external and internal fistulous openings.

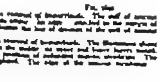
Step 4. Probe the fistula at either opening (Fig. 1694). It may be necessary to locate one of the openings. Do not probe into healthy tissue. Inject methylene blue.

Step 5. Replace the probe by a grooved director; incise the fistula (Fig.

1695) down to the director perpendicular to the sphincter ani (Fig. 1696). Curet the wall of the tract and, if it is not to be sutured, trim off the overhanging skin, creating a clean trough.

Step 6. Examine carefully for other tracts and treat them similarly.

Step 7. Leave the wound open and pack lightly with vaselined gauze. Some close the wound tightly using catgut. In the



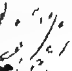


Fig. 1690. Fig. 1691.

Fig. 1690. Whitehead's operation for the removal of hemorrhoids. The cuff of mucous membrane is drawn taut preparatory to suture. An edge is attached to the margin of the wound by sutures. The dotted line indicates the line of division of the cuff of mucous membrane in the middle.

Fig. 1691. Whitehead operation for the removal of hemorrhoids. The illustration shows closure of the cuff of mucous membrane held in the middle, an upper and lower layer sutured. The dotted line indicates the outside line of junction of anal mucous membrane. The illustration below shows the operation completed. The edges of the mucous membrane sutured to the margins of the wound.

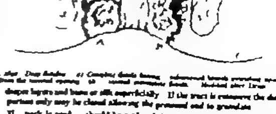


Fig. 1693. Deep fistulas. A: Complete fistula leaving a subcutaneous branch extending upward from the internal opening. B: Internal incomplete fistula. (Modified after Lynch.)

deeper layers and leave or silk superficially. If the tract is extensive the distal portion only may be closed allowing the proximal end to granulate.

If a pack is used, it should be replaced daily for 4 to 5 days, followed by bowel action and sitz baths.

Fistulectomy or Excision of the Fistula

Proceed as in the previous operation, but instead of incising excise it around a probe as in Fig. 1695. Or dissection or coagulation

Step 1. Dilate the fistulous tract as in fistulotomy
Step 2. Make an ample elliptical incision around the external opening
Step 3. The circumscribed opening of the fistula is grasped with forceps and, while exerting gentle traction, the entire tract is dissected out together with the adjoining healthy tissue
Step 4. The wound may be left open and packed lightly or on occasion, completely closed with interrupted sutures. It is, as a rule, unwise to close the medial end

Fig. 1592

Fig. 1593

Fig. 1592. Complete fistulectomy. Flexible sound emerging from common opening of fistula through internal opening.

Fig. 1593. Fistula in ano. The passage of a sound introduced through the external opening of the fistula emerges through the internal opening and the anal canal.

Kenneth Mackenzie's Fistulectomy

This is indicated particularly in extensive fistulae

Step 1. Prepare the operative area
Step 2. Thoroughly dilate the sphincter
Step 3. Carefully dilate the internal fistulous opening. Uplift the mucous membrane and part it in the long axis of the bowel. The underlying muscle is trimmed and excised. If necessary split the internal opening in the direction of the sphincter ani. The rectal wall is then closed by interrupted sutured sutures. The mucous membrane is then closed.
Step 4. A semilunar incision is now made on the involved side just lateral to the external sphincter ani and extended up until it divides the tract flush at its emergence from the bowel. The incision is then carried laterally so the ends making a long deep flap to expose all the accessible branches of the fistula (Fig. 1595)
Step 5. Excise thoroughly with knife or curved scissors all branching tracts leaving only healthy tissue.
Step 6. Inlaid rectal wall once or twice over the [illegible] suture line depending on the existing conditions.
Step 7. Flush the field with normal saline solution and close the wound. Drainage is optional.

Ligature Operation

This is done effectively under local anesthesia

Step 1. Prepare the field of operation as usual
Step 2. A soft piece of rubber silk or linen ligature is threaded through the fistulous tract after passing a probe carrying a thread to which the ligature is attached (Fig. 1595)

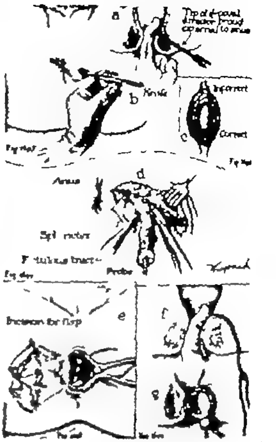


Fig. 1594 (a and b). A grooved director has been passed along the fistulous tract and its point brought out of the anus (a). A knife (b) divides the tissues overlying the director.
Fig. 1595 (c). Correct and incorrect method of dividing the sphincter. [illegible]
Fig. 1595 (d). Method of dissecting fistula.
Fig. 1595 (e). The Kenneth Mackenzie method of operating for fistula.
Fig. 1596. Treatment of fistula [illegible]

Step 3. The ligature is then tightly tied as depicted in Fig. 1595 and left in place until it has cut through the tract. This usually requires 5 to 6 days, but in large fistulae it may be much longer. Following this the wound is irrigated daily.

PROLAPSE OF THE RECTUM

Prolapse of the rectum may be complete or incomplete: complete when all coats of the bowel are involved; incomplete when only the mucous membrane is affected (Fig. 1597). The condition may be congenital or acquired. In congenital prolapse the natural supports of the rectum are absent. Acquired prolapse may be due to a number of causes.

Incomplete Prolapse. Palliative methods, strapping of the buttocks etc. are often successful. If unsuccessful resort to Whitehead operation (p. [illegible]) Although linear cauterizations will sometimes overcome the prolapse.

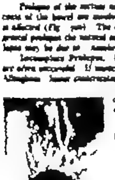


Fig. 1597. Prolapsed rectum

Complete Prolapse. In this condition all the coats of the bowel are involved. There are three degrees of complete prolapse.

LOCKHART-MUMMERY'S OPERATION

Step 1. Proper preoperative preparation of the patient is essential. The bowels must remain inactive for five days after the operation.

Increase the degree of the rectal prolapse. Place the patient in the lithotomy position; place a small sandbag under the sacrum. Clean out the rectum (irrigations with lysol [illegible] drachm to a pint of water). Cleanse the perineal area with ethers followed by iodine.

Step 2. Make a transverse incision about [illegible] inches in length at a point half way between the tip of the coccyx and the posterior margin of the anus. Deepen the incision slightly toward the coccyx. Completely divide the attachment of the external sphincter to the coccyx. Dissect backward until you open the posterior rectal space. Avoid opening the rectum during this step of the operation.

Step 3. Introduce a gloved finger through the incision into the posterior rectal space; open the space thoroughly on each side of the rectum and up along the hollow of the sacrum. Usually there is no difficulty encountered in stripping the rectum because the cellular tissue is loose by reason of the prolapse. Separation upward should be about equal to the prolapse when down. Blunt dissection and sponges are the keynotes here. The posterior and lateral aspects of the rectum must be freed.

Step 4. [illegible] Pack the whole area posterior and lateral to the rectum with gauze (1-inch ribbon gauze with a selvage) prepared as follows. Pack a wide-mouthed bottle tight with gauze. Sterilize it. Pour hot melted vaseline into the bottle until full. Heat the bottle in the sterilizer, pour some more vaseline on the gauze until it is thoroughly saturated. Screw the cap on the bottle and return it to the autoclave. Five or six yards

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of gauze thus prepared should be available and should be packed carefully into the hollow of the sacrum and above the levator ani muscles, thus to avoid primary union of the rectum and walls of the pelvis. If more gauze is needed the end of the first supply should be tied to the next pack thus avoiding the possibility of losing some gauze.

Step 5. Close the wound temporarily with a suture. Unless the external sphincter is competent, do some plastic operation on it now or before the patient leaves the bed.

Step 6. Put a small tube in the rectum. Drain.

Step 7. Dress the wound twice daily. Do not remove the packing for a week.

At the end of that time give an anesthetic, reopen the wound. Repack the cavity with vaselined gauze. Leave the ends of the gauze protruding from the wound. Leave this packing in for a week.

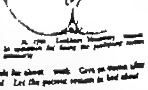


Fig. 1598. Lockhart-Mummery [illegible] in operation for fixing the prolapsed rectum posteriorly.

Step 8. Remove packings after a week. Do not repack. Introduce a drainage tube into the cavity. Do not allow the wound to heal before three weeks. The more slowly it heals, the better the result. Confine the bowels for about a week. Give an enema after that, before the packing is removed. Let the patient remain in bed about a month if the prolapse is marked.

Comment. The anterior wall of the rectum is not fixed by this operation. If the prolapse is very marked, Lockhart-Mummery fixes the anterior wall at the same time by a modification of McCann's operation, by suturing together the anterior portions of the levator muscles. Lockhart-Mummery used this operation for over twenty years in over fifty patients with only six recurrences (two of these patients were mentally deficient).

Fixation of the Anterior Wall of the Rectum
(LOCKHART-MUMMERY)

Step 1. Place the patient in the lithotomy position. Make an incision as shown in Fig. 1598.

Step 2. Dissect free the lower end of the rectum and anal sphincter for about two inches.

Step 3. Expose the anterior attachments of the levator ani muscles. The opening is narrowed by some catgut sutures introduced from side to side which pick up the sphincter muscle together with the outer coat of the rectum and adjacent structures. Do not enter the rectum.

Step 4. Introduce tension sutures of silkworm gut. These will relieve tension on the catgut sutures.

Step 5. Close the skin.

Comment. This operation is effective in fixing the anterior wall of the rectum and restoring the normal caliber of the anal canal. It may be used in men and women.

Excision and Amputation of the Rectum for Prolapse

In prolapse of moderate degree this operation is not difficult. In marked prolapse it is dangerous (shock, opening peritoneal cavity, peritonitis, injury to small bowel, etc.). Recurrences are common.

Mass and Rives Operation

Urban Mass and J. D. Rives described their operation for complete prolapse of the rectum which consists of the following steps:

Step 1. Place the patient in the lithotomy position and reduce the prolapse. Make an inverted Y-incision so that the arms include the anus (Fig. 1707 A). Expose the external sphincter.

Step 2. Incise the anobulbar raphé transversely, liberating the sphincter from the middle tendon of the perineum. Excise the anterior quadrant of the external sphincter and suture the muscle end-to-end with U-sutures of chromicized catgut.

Step 3. Expose the levator ani. Expose its medial borders by means of blunt dissection. Using a finger or a pack in the rectum as a guide, expose the anterior and lateral walls of the rectum as far as the lateral ligaments. A gauze-covered finger serves as a satisfactory blunt dissector for this purpose.

Step 4. Thrust forward the prostate and seminal vesicles. If the cul-de-sac is very deep, gently push up the reflection of peritoneum from the rectum to the prostate exposing the latter anteriorly and the adventitia of the rectum as far as the finger will reach, posteriorly. The upper surface of the levator ani which is covered by the pelvic fascia, now forms the lateral wall of the space.

Step 5. Start at the apex of this artificial vagina and insert sutures to approximate the levators and suspend the rectum. Use chromicized catgut on full curved, round needles. Take a deep bite of the levator ani fascia on the right, and carry the needle down an inch or an inch and a half. Include several transverse stitches across the lateral and anterior aspects of the rectal walls (Fig. 1707). From here direct the needle to a point on the left levator which corresponds to the first bite on the right and take a similar stitch. Insert three or four sutures of the same type at short intervals until the free margins of the levators are reached. When these sutures are tied, they serve to approximate the levator ani, suspend and plicate the rectum and close the depth of the cul-de-sac. The final suture approximates the free margins of the levators but does not include the rectum. This forces the anus backward and reproduces the normal backward angulation of the anal canal.

Comment. Where the pelvic floor is extremely relaxed, the above procedure may be supplemented by fixing the posterior wall of the rectum in accordance with Tuttle's method. In case mucous membrane prolapse occurs, it may be corrected by linear cauterization or excision. The procedure is not complex and produces very little shock. It is quite practical with spinal or local anesthesia. In a later personal communication (1938)

Surgery, Gynecology and Obstetrics, '34.

Dr. Mass informed me that he had performed several of these operations and that he, as well as those who have used the method, found it entirely satisfactory.

RENN DÉLORME OPERATION FOR RECTAL PROLAPSE

The resection of the mucous membrane is here analogous, in a sense, to the Whitehead operation. It is performed as follows:

Step 1. Make a circular incision at the mucocutaneous junction.

Step 2. The mucous membrane is now dissected from the subjacent structures in the form of a cylinder, care being taken not to inflict injury to the in-

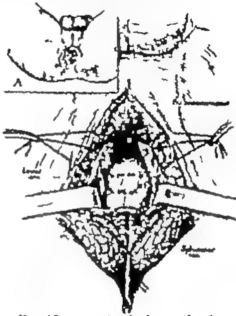


Fig. 1707. Mass and Rives operation for prolapsed rectum. (Surg., Gynec. and Obst., [illegible])

ternal sphincter muscle situated immediately under the submucosa, at the mucocutaneous junction. In order to successfully perform this step of the operation, two important factors are to be observed: first, to work carefully in the proper line of cleavage; second, perfect hemostasis. When the apex

of the prolapse has been reached, a segment of from 7-10 cm. of the muscular surface of the bowel is exposed (Fig. 1709).

Step 3. This step consists of folding the denuded bowel in an accordion-like manner, by means of 5 or 6 folding sutures of silk or catgut. The suture

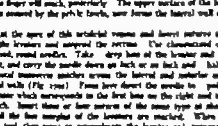


Fig. 1708. The Renn-Délorme operation for prolapsed rectum. Left: The [illegible] cuff of mucous membrane surrounding the rectum has been dissected free to the [illegible] of the prolapse. [illegible] sutures are shown which [illegible] the [illegible] of the bowel and gather up the [illegible]. Right: [illegible] The suture below the illustration diagrammatically [illegible] the cuff of mucous membrane [illegible].

is begun at the mucocutaneous junction and successive segments of bowel are picked up until the dissected cuff of mucous membrane is reached at the apex. By tying the sutures it will be observed that the mucomuscular tube

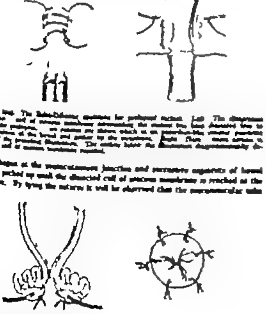


Fig. 1709. The Renn-Délorme operation for prolapsed rectum. Left: Observe [illegible] the sutures are tied [illegible] of the bowel. [illegible] Right: [illegible] the [illegible] interrupted sutures unite the [illegible] (After Pepper.)

is plicated and the prolapsed segment slips up into the pelvis above the sphincter ani muscle (Fig. 1709).

Step 4. Ablate the dissected cylinder of mucous membrane. The remaining external sphincter may be reinforced and narrowed by catgut sutures so placed laterally as to diminish the outlet.

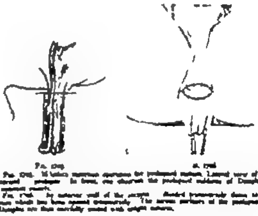


Fig. 1710. Fig. 1711.

Fig. 1710. M[illegible] operation for prolapsed rectum. Lateral view of [illegible] prolapse. In front, one observes the prolapsed cul-de-sac of Douglas, behind the external sphincter.

Fig. 1711. The anterior wall of the rectum [illegible] divided transversely down to the [illegible] which has been opened transversely. The serous surfaces of the prolapsed cul-de-sac of Douglas are then carefully united with catgut sutures.

Fig. 1712. Upper illustration shows the anterior wall of the inner portion of tube opened. Lower illustration depicts the outer and inner mucous membranes [illegible] interrupted sutures.

Comment. The advantage of this method over total resection of the prolapsed segment lies in the fact that the peritoneal cavity is not entered.

Resection Operation for Prolapsed Rectum (Mikulicz, 1889)

Mikulicz was preceded by [illegible], Dieffenbach, [illegible] and Frank, who laid down the principles of the operation while Mikulicz perfected the technic. (Fig. 703.)

Step 1. Introduce two traction sutures through the apex of the prolapse. About [illegible] cm. from the anal fold an incision is made dividing anteriorly the various layers of the bowel. Ligate bleeding vessels. (Fig. 706.)

Step 2. Open the peritoneum transversely and completely. Search for pro-

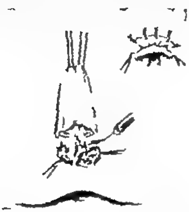


Fig. 706. Mikulicz resection operation for prolapsed rectum. [illegible]

lapsed small bowel. If found, replace it. Now close the peritoneal cavity by suturing the opposed peritoneal surfaces.

Step 3. The anterior wall of the prolapsed bowel is now divided. [illegible] the [illegible] of the [illegible] wall with interrupted sutures all the way around (Fig. 707). Attend to careful hemostasis. Momentarily leave the ends of the sutures long to be used for traction.

Step 4. Divide the posterior section of the prolapsed rectum (both layers). [illegible] while performing this step, the prolapsed segment upward as shown in the illustration. Usually the peritoneum does not appear here, the meso-colon presenting. This will have to be carefully and thoroughly ligated and divided (Fig. 708).

Step 5. Make sure that all bleeding points are under control. Cut the sutures short. Replace the short stump.

Comment. It must be remembered that this operation gives [illegible] of about [illegible] per cent (Lockhart-Mummery). Less dangerous methods, above described, should first be attempted.

Reid's Method of Treating Irreducible Prolapsed Rectum

Mont R. Reid described a method of treating irreducible prolapse of the rectum[1] as follows:

A Chinese girl, aged eight, was admitted to the Peking Union Medical College Hospital with an edematous and sloughing prolapse of the rectum which was about 5 inches in length. The condition had been present for a long time and it was obvious that no attempt should be made to reduce it. The normal opening of the gut was at the apex of the protruding mass. There was no evidence of intestinal obstruction. It was easy to insert a rubber tubing, about an inch in diameter, into the prolapsed rectum and to pass it through the sphincters well up into the rectum. With this tube then placed around it we palpated the prolapse surrounding it and were sure there was no herniation of intestine into a peritoneal pouch. At the junction of the [illegible] with the [illegible] the edema was less and it was at this point that palpation was most satisfactory and convincing. Consequently the tube was anchored in situ by means of a couple of heavy silk sutures at the apex of the prolapse. Next a constricting rubber band was placed around the prolapse at the normal surface level of the anus and just distal to the external sphincter muscle (Fig. 1709). The band stopped the circulation to the prolapse and also occluded any peritoneal pouch that might have been present. For several hours the child was watched most carefully for evidences of intestinal obstruction. At the end of two weeks, during which time there were normal defecation and expulsion of gas through the tube, the entire prolapse sloughed away. A spontaneous anastomosis had occurred at the level of the rubber band. Tone quickly returned to the muscles and at the time of her discharge from the hospital there was good sphincter control and no evidence of rectal stricture. We believed that the procedure had definitely lessened the chances of peritonitis which would have attended surgical amputation of the prolapse and suture in the presence of so much infection and necrosis.

Reid treated other similar cases with success. He states:

"In the treatment of irreducible and strangulated prolapse of the rectum, it seems to us that the method described and illustrated offers, when its use is not definitely contraindicated, a simple solution to a very difficult problem and should lessen very materially the danger of peritonitis. This method or its principle may prove to have value in the treatment of certain types of recurring prolapse in adults, and possibly in connection with total excision of the rectum when there is any endeavor to restore the anus and to retain normal sphincter control."

Owen H. Wangensteen of Minneapolis had occasion to use Reid's method. He states, "A case is reported in which prolapse of the rectum was treated by strangulating the prolapsed gut by rubber bands, a method recently described

[1] Am. Jour. Surgery, [illegible]
[2] [illegible], April, [illegible]

by Reid. This simple but effectual method apparently is an old one which has been in use for fifty or sixty years. In instances of incarcerated or strangulated prolapse it should be the method of choice. In adults who may be treated by

Fig. 1709. Prolapse of rectum [illegible] rubber tube [illegible] (Courtesy of Dr. Mont R. Reid.)

an elective method, the simple means should receive favorable consideration. Prolapse in children, on the whole I believe, may be as efficiently treated by alcohol injection into the rectal wall or by the Ekehorn operation (p. 1337). In applying an elastic ligature over the prolapse, care should be taken that no coils

of small intestine are in the cul-de-sac, which usually extends down to the apex of the intussusceptum."

VISCEROPTOSIS

This condition may involve one or all of the organs of the abdomen, consequently the operation indicated may be quite simple or very complicated.

In some instances prolapsed viscera, colon or other portions of the abdominal contents may be an indication for splenopexy, hepatopexy, gastropexy, [illegible], colopexy, sigmoidopexy or [illegible]. [illegible] have in many instances brought relief (see gastropexy).

Surgery is frequently more effective in treating these cases than other methods employed. However the patient's general condition should be improved prior to undertaking any of these operations.

Cecopexy, colopexy and sigmoidopexy are simple procedures and are practically free from danger. Gastropexy may be indicated if the whole colon is displaced. The technic for these procedures is similar to that employed for sigmoidopexy which is shown in Fig. [illegible] on p. [illegible].

Sigmoido- and Proctopexy

Suspension operations may be resorted to either via the abdomen or through the pelvic floor.

Posterior Proctopexy

(Tuttle, [illegible], [illegible], Verneuil, Ekehorn)

The underlying principles of this procedure are: (a) Posterior longitudinal or semicircular incision between the tip of the coccyx and anus. (b) by means of a long-handled needle the muscular coat of the prolapsed bowel is transfixed and carried upward through the wound and brought out at the sides of the sacrum and (c) then tied over a pad of gauze.

SIGMOIDOPEXY

(Allingham's Technic)

Moschcowitz obliterates the cul-de-sac of Douglas and peritoneal folds by introducing purse string sutures in the peritoneum around the bowel and attaching the peritoneum to the pelvic fascia, uterus and [illegible] of the bowel, thus supporting the prolapsed rectum. In doing this operation avoid the ureter.

SIGMOIDOPEXY

([illegible] Technic)

Step 1. Make a [illegible]-inch long incision in the left rectus or [illegible] inches [illegible] 4 inches long.

Step 2. Locate the sigmoid flexure or colon and free it from adhesions. [illegible] [illegible] for ptosis and obstruction.

Step 3. Scarify the surfaces to be apposed and insert a few heavy sutures under the longitudinal band and wall of the abdomen (Fig. 1710).

Step 4. Remove portions of the peritoneum on each side of the sutures, thus facilitating the agglutination of the bowel and lateral lining.

Step 5. Approximate the fascia and muscle with chromicized catgut in the form of a lock-stitch; close the skin with continuous or interrupted sutures of

catgut, silk or linen. A few interrupted, figure-of-eight silkworm-gut sutures are inserted if the incision is large or has a tendency to pull.

Fig. 1770. Colopexy. Method of [illegible] [illegible] [illegible] the colon with the [illegible] [illegible].

Step 6. Tie the [illegible] [illegible] stitches across rubber tubing and apply sterile dressing.

Comment. Suture the bowel to the abdomen in the shape of a curve, placing the stitches about an inch apart to prevent stenosis. In colopexy the bowel is attached to the abdominal wall in one or several places; when [illegible] it is attached after cecostomy or colosigmoidostomy is done (Figs. 1710-1711).

Pneumocolopexy has been known to overcome coloptosis and stimulate the colon, the latter being due to the movements of the diaphragm.

In cases of ptosis complicated by marked dilatation, colopexy with invagination has been known to be effective. It is accomplished by the invagination and lengthening of one portion of the colon into another and securing the bowel in position. This should be followed by colopexy.

Fig. 1771 Fig. 1772

Fig. 1771. Marked [illegible] [illegible] [illegible] [illegible] and [illegible].

Fig. 1772. [illegible] [illegible] after colopexy [illegible] [illegible] [illegible] [illegible] [illegible] marked physical [illegible].

In cases of splanchnoptosis complicated by gastroptosis, Rovsing's gastropexy or Coffey's [illegible] should supplement colopexy p. 1093, Figs. 1476-1479.

CRYPTITIS AND PECTENOSIS
CRYPTECTOMY; PECTENOTOMY

A number of longitudinal folds lie at the end of the anal mucous membrane. A depression occurs between each group of folds and dips down forming a little pocket which is called a crypt of Morgagni. Foreign bodies of fecal particles sometimes gather in these pockets causing ulceration and sometimes abscesses. The treatment consists in removing these crypts (cryptectomy).

If palliative measures are unsuccessful, the following procedure is resorted to: expose the crypt fully. Introduce a probe into the crypt. Exert traction on the probe and with scissors, curved on the flat, excise the entire valve and crypt. Stretch the sphincter gently. Insert a small piece of iodoform gauze

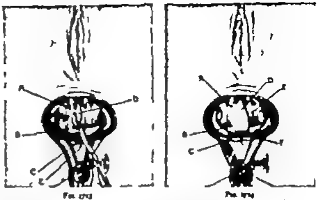


Fig. 1773 Fig. 1774

Fig. 1773. Pectenotomy. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] is made through the anal mucosa parallel to the long axis of the bowel, extending from above the pectinate line to below the [illegible] line. A, pectinate line; B, Hilton's line; C, [illegible] [illegible] line; D, pecten band [illegible] [illegible] [illegible] [illegible]; E, [illegible] line.

Fig. 1774. Pecten band exposed, ready to be [illegible] in the [illegible] [illegible] [illegible]. A, pectinate line; B, Hilton's line; C, [illegible] line; D, pecten band; E, [illegible] and [illegible]; F, sphincter muscle below band.

over the cut surface. After-treatment: local applications of ichthyol or silver nitrate to the raw surface until it is entirely healed.

Maurice O. Spiesman[1] confirmed the studies of Miles and Abel on the existence of the pecten band and its pathology (pectenosis) as well as its relief by pectenotomy. It is depicted in Figs. 1773-1774-1775. The conclusions that Spiesman has drawn from a study of 309 cases of pectenosis are that it is a common chronic anal condition, relieved only by pectenotomy. Anorectal divulsion has proved to be unnecessary and has been replaced by pectenotomy in many instances. Pectenotomy is indicated in anal fissure, fistula-in-ano, cryptitis, papil-

[1] Ill. Med. Jour., Dec., 1936.

litis, pruritus ani, anal spasm in some types of hemorrhoids and in any other anal condition associated with tightness of the sphincter.

PRURITUS ANI

In long-standing cases of pruritus which have failed to respond to medical treatment and where no definite cause for the itching can be found, a cure may be effected by the following procedure:

Unterseesed Desiccation

The active electrode is brought close to the skin. In aggravated cases the skin is punctured superficially. Desiccation must be complete in the area subjected to treatment. In advanced cases 2-3 treatments may be required. The surfaces subjected to treatment heal in about a month.

Aggravated cases may not yield to simple desiccation; this is also true where the perianal tissues are involved. Under such circumstances, excision of the affected area with the diathermy knife followed by suture of the raw

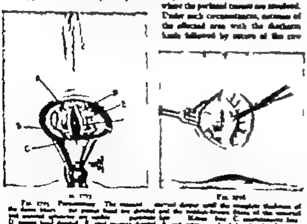


Fig. 1775 Fig. 1776

Fig. 1775. Pectenotomy. The [illegible] [illegible] [illegible] until the complete thickness of the [illegible] [illegible] the pecten band are divided and the [illegible] [illegible] [illegible] of the [illegible] and external sphincter are visible. A, pectinate line; B, Hilton's line; C, [illegible] line; D, pecten band divided; E, anal mucosa divided; F, sphincter muscles below band. (Courtesy of Dr. [illegible] Spiesman.)

Fig. 1776. Chevron Ball's operation for pruritus ani. Note bilateral incision and exposure of nerves which are transected for purposes of [illegible].

area will bring about relief. Avoid coagulation during cutting if primary union is the aim.

Ball's Operation for Pruritus Ani

The principle underlying this operation consists of dividing the terminal branches of the nerves which supply the affected skin.

Step 1. Place the patient in the lithotomy position. Make an incision (Fig. 1776) on one side of the anus through the skin and subcutaneous tissue. Retract the flap thus exposing the fibers of the external sphincter. Con-

tinue the incision up to and beyond the mucocutaneous junction. Undermine the skin for a short distance on either side of the original incision with scissors.

Step 2. Make a similar incision on the opposite side of the anus reflecting the flap as in the previous step.

Step 3. Undermine the bridges of skin with scissors. Attend to hemostasis.

Step 4. Suture the incisions after replacing the flaps. Drain. Lockhart-Mummery[2] endorses this operation strongly.

Kraske's Operation

This operation is the same as Ball's except that six linear incisions are made radiating from the anus and following a circular path around the anal canal.

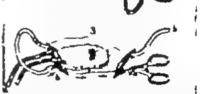


Fig. 1777. Dr. Harry E. Buie's operation for anal [illegible]. [illegible]. (Courtesy of Dr. H. [illegible] Buie.)

Instead of making two elliptical incisions there are four lateral incisions, two anterior and two posterior. Between these folds, the skin is dissected up temporarily severing the sensory nerves. [illegible]
operation has over Ball's is that the
has been corroborated

[2] Brit. Med. Jour., Aug. 12, 1925.

STONE'S PROCEDURE FOR ANAL INCONTINENCE

(Based on Wreden Principle)

Harvey B. Stone[1] copes with this distressing condition as follows

Step 1. Place the patient in the lithotomy position after as careful cleansing of the field as possible, including cleansing enemas for two days previous to operation.

Step 2. Make two symmetrical incisions, one on each side, about 4 cm. lateral to the anal margin and slightly posterior to it. These incisions slant somewhat laterally toward their anterior ends, are about [illegible] cm. long and are carried well into the subcutaneous fat (Fig. [illegible]).

Step 3. A closed long, curved Kelly clamp is introduced through one incision and by blunt dissection is forced around, through the subcutaneous tissues in front of the anus. Its tip is made to emerge into the other incision. (Fig. [illegible])

Fig. [illegible]. The Wreden-Stone operation for anal incontinence. [illegible] (After Harvey B. Stone, Arch. Surg. [illegible])

Step 4. Open the clamp and grasp the ends of two strips of fascia, [illegible] cm. wide and from [illegible] to [illegible] cm. long. (This fascia may be either autogenous from the patient's fascia lata or prepared by the Koontz method.)

The clamp grasping the strips of fascia is then withdrawn the way it was introduced. This threads both strips of fascia in front of the anus. A second Kelly clamp now grasps the end of one of the strips. It passed again into one of the incisions and is forced to burrow its way subcutaneously to the other incision, this time behind the anal canal. As it emerges into the opposite wound, the strip of fascia clamped to its tip is carried and more of it drawn through the wound. This strip now encircles the anus, subcutaneously entering at one incision, and its opposite end emerging from the same incision (Fig. [illegible])

Step 5. The clamp which meanwhile has remained in its posterior tunnel, is opened, grasps the free end of the second strip of fascia and is pulled back

[1] Arch. of Surg., Jan. [illegible]

the way it was pushed in. It brings back with it the end of the second strip of fascia, which now encircles the anus subcutaneously, but in the opposite direction to the first: both protrude through the same incision. (Fig. [illegible])

Step 6. From one of the incisions blunt dissection is now carried outward and backward fairly deep in the fat until the outer edge of the gluteus maximus is reached and identified. A bundle of fibers of this muscle about as thick as the index finger is now surrounded by one end of the strip of fascia protruding from the incision. This may be done easiest by carrying a heavy thread in an aneurysm needle around the muscle and using the thread as a tractor, tied to the end of the strip of fascia, to pull the strip around the muscle bundle as shown in Fig. [illegible]

Step 7. This end of the strip is now brought back into the incision and tied tightly to its own other end, thus forming a closed loop, one end of which encircles the anal canal and the other encircles a bundle of gluteus muscle (Fig. [illegible]).

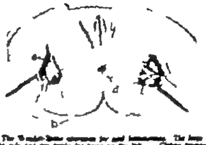


Fig. [illegible]. The Wreden-Stone operation for anal incontinence. [illegible]

Step 8. Execute exactly the same steps in the other incision with the two ends of the other strip of fascia. The knotted ends of the fascia sink into the depths of the wounds.

Step 9. The skin is closed in the usual manner.

Step 10. Seal the two small incisions with some impervious dressing. Keep the bowels locked up for from seven to ten days following the operation.

Comment. The anus now is encircled by two loops of fascia, running into opposite directions, and under some tension about bundles of gluteal muscle. When the gluteal are voluntarily contracted they will pull the loops with tighter and give [illegible] mechanism for voluntary control in closing pressure on the anal canal.

Stone's method differs from Wreden's and from his own first method by reducing the number of incisions from four to two and by moving them two further from the anal orifice. If infection can be avoided, the percentage of good results should be high. The operation depends on the

utilization of the gluteus muscles. If these muscles for any reason are not functioning, the operation cannot be expected to succeed. Also, until the patient learns to use the glutei properly the full benefit is not obtained. Hence education of the patient in this regard is important. He must be trained to contract the buttocks when necessary. It follows that patients who cannot be taught to do this, because of lack of interest or intelligence, do not improve as much as others. The last case reported by Stone was an instance in point. He states "The anatomic and surgical result was excellent, but the patient did not always remember to use his new power of anal control. Because of this necessity for education, the patients in successful cases do not show as much improvement immediately as they will ultimately.

[illegible]

CHAPTER 33

SURGERY OF THE LIVER, GALLBLADDER AND BILIARY PASSAGES

OPERATIONS ON THE LIVER

Anatomic Considerations. The greater part of the liver is situated in the right hypochondrium. Portions of the organ extend into the right and left epigastrium, the right lumbar and right umbilical regions and a small portion into the left hypochondrium.

The subphrenic space is located between the diaphragm and the upper surface of the liver. The suspensory ligament divides this space into two compartments (right and left). Fluid collections in the right subphrenic space may result from

(a) suppurations in the liver and bile passages
(b) appendiceal abscess
(c) empyema thoracis
(d) suppurative lesions of the right kidney

Fluid accumulations in the left subphrenic space may result from

(a) perforation of gastric ulcer
(b) abscess of the spleen
(c) empyema thoracis
(d) suppurative conditions of the left kidney

The Portal Circulation. (Fig. [illegible]) The liver receives its blood supply from the (a) hepatic artery and the (b) portal vein.

The hepatic artery, a branch of the celiac axis runs to the right of the lesser omentum (hepato-duodenal ligament). At the porta hepatis, it divides into right and left branch. The cystic artery usually arises from the right hepatic branch and courses along the cystic duct and the neck of the gallbladder. The gastro-duodenalis artery, a branch of the hepatic artery, runs downward and backward along the medial border of the duodenum. It gives off branches to the common duct. It terminates in the right gastro-epiploic and the superior pancreatico-duodenalis arteries.

The hepatic veins empty into the vena cava inferior. The portal vein drains the pancreas-spleen and the whole of the abdominal portion of the gastrointestinal tract with the exception of the lower part of the rectum and the anal canal.

It takes origin from the union of the splenic and superior mesenteric veins and passes through the lesser omentum to the portal fissure of the liver. The cystic, coronary (left gastric) and pyloric (right gastric) veins empty into the portal vein directly.

The superior mesenteric vein receives the veins of the small intestine, the ileo-colic, the right colic, the middle colic, the right gastro-epiploic and the pancreatico-duodenal veins.

The splenic vein receives the vasa brevia, the left gastro-epiploic, the pancreatic and the inferior mesenteric veins.

The inferior mesenteric vein is formed by the junction of the superior hemorrhoidal and sigmoid veins. In its course it gathers the left colic veins and enters the splenic vein.

In cirrhosis of the liver, carcinoma, severe forms of cholelithiasis, and in certain other pathological conditions, an obstruction to the portal circulation may ensue. Such results in diverting some of the blood into the systemic circulation along certain anastomotic channels, [illegible]

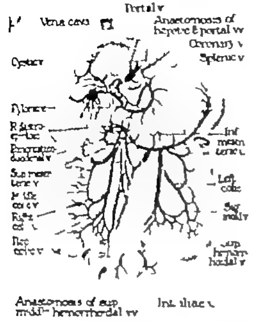


Fig. [illegible] The portal system and the venous routes by which portal blood may reach vena cava.

(1) Through the left gastric (coronary) vein into the esophageal venous plexus and from here to the azygos and hemiazygos veins eventuating in varicosities of the esophageal veins. These often rupture causing alarming hemorrhage.

(2) Through the superior into the inferior hemorrhoidal vein to the hemorrhoidal plexus causing hemorrhoids. The inferior hemorrhoidal vein empties into the internal iliac vein.

(3) Through the para-umbilical to the superficial umbilical veins to the

veins of the anterior abdominal wall. The para-umbilical vein courses along the ligamentum teres hepatis and empties into the left branch of the portal vein, which becomes dilated in portal obstruction resulting in the formation of so-called caput medusae. (Varicosities of the superficial epigastric particularly around the umbilicus.)

(4) Smaller anastomotic routes between the mesenteric and lumbar veins in the retroperitoneal space.

Lymphatics of the Liver. There are two sets: (a) in the transverse fissure and (b) in the gastro-hepatic omentum. Both sets drain into the coeliac nodes.

Nerve Supply. From two sources: (a) the left vagus and (b) branches from the coeliac sympathetic plexus.

Operations on the liver are performed for either injury or disease.

I. Injuries. (a) subcutaneous injuries causing crushing of the liver; (b) open wounds (gunshot or stab wounds).

II. Disease. (a) abscess of the liver; (b) subdiaphragmatic abscess; (c) echinococcus; (d) cirrhosis; (e) tumors of the liver.

APPROACH TO THE LIVER

The two most important factors to be considered in operations on the liver are exposure and arrest of hemorrhage. Exposure is accomplished by either an (a) anterior abdominal incision, (b) anterior transpleural approach or (c) posterior transpleural approach.

In doubtful cases explore through an ample midline incision. This approach may however be inadequate in injuries to the dome of the liver. In such cases one must resort to reflecting the lower costal arch. This is effected by the Marwedel procedure, by reflecting a costo-chondral flap or by costectomy (rib resection). Normally if the approach is planned below the seventh rib, between the sternal and mammary line, injury to the pleura is not to be feared. In the midaxillary line the pleura extends as far down as the ninth rib and to the twelfth rib at the side of the spine.

Transpleural Route. Place the patient on the left side. Expose the 9th or 10th rib by an incision running parallel to the rib selected. Resect about 3 inches of the rib. One or more ribs may be resected, if need be. Open the pleura for about 1½ inches. Suture the opened pleura to the borders of the opening in the diaphragm.

The posterior surface of the liver (right lobe) is not covered by peritoneum. It is attached directly to the posterior aspect of the diaphragm. It can, therefore, be directly approached without opening the peritoneum. In operating in this situation remember the position of the inferior vena cava.

INJURIES TO THE LIVER

Subcutaneous Crushing Injuries

Step 1. Explore thoroughly until the injured part is located.

Step 2. Evacuate the accumulated free blood by suction or mopping with lap sponges.

Step 3. Tamponade or suture (mattress suture with catgut) or combine tamponade with suture, or secure hemostasis by electrosurgical means.

Step 4. Drain; close the abdominal wall.

The suture line may be reinforced by suturing the falciform ligament over [illegible]

Electrocoagulation offers an excellent means for hemostasis. It must not, however, be compared in action with electrocauterization. The Paquelin and thermocautery are not reliable and have different effects than coagulation.

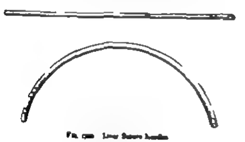


Fig. [illegible] Liver Suture Needle.

Kirschner recommends a most valuable measure for lessening operative bleeding by injecting the operative field with adrenalin solution (10 drops of 1:1000 adrenalin solution in 100 cc of saline solution) with which the liver

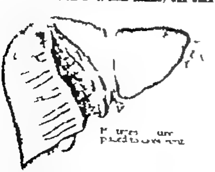


Fig. [illegible] Method of closing [illegible] the liver with mattress sutures. [illegible] Recommended by Rutherford Morison.

tissue in the region of the incision or in the neighborhood of the operation is thoroughly infiltrated, using a long narrow needle. Liver tissue thus treated becomes edematous, assuming a whitish color.

Temporary hemostasis may be effected by compressing the vessels in the hepatoduodenal ligament. The second or the third fingers of the left hand are inserted through the foramen of Winslow; they grasp the posterior surface of the ligament while the thumb compresses the bleeding vessels from the front.

Repair of Rent in the Liver

Step 1. Anesthetize the patient. Open the abdomen.

If hemorrhage is free resort to immediate temporary hemostasis by Pringle method (p. [illegible])

If the rent is on the antero-superior surface of the liver the wounded area will be made more accessible by using a sufficient number of lap sponges between the dome of the liver and the diaphragm.

In postero-lateral injuries use the transpleural route.

Step 2. Tamponade. Sterile gauze dipped in turpentine is very effectual. Where suture is difficult, tamponade is the only recourse. I prefer to leave the pack in situ for six or seven days. Be prepared for repacking when removing the tampon.

Step 3. Suturing the Rent. Use special liver suture needle (Fig. [illegible]) carrying heavy chromic catgut. Or in the absence of such, the largest size curved catgut needle (Mayo pattern) passed eye first. The sutures should be of mattress type; they should be approximated and not strangulated. Remember liver tissue is extremely friable (Fig. [illegible]). For other suturing methods see p. [illegible]

Fig. [illegible] Method [illegible] of the liver. (After [illegible] and [illegible])

Suture and tamponade may be advantageously combined in certain cases. The sutures approximate the liver tissue over the tamponed area.

Open Wounds (Gunshot or Stab)

Proceed as outlined above. When bile is found, search for its source. Cholecystectomy may be indicated or cholecystostomy may be done, or repair of the ducts may be indicated.

HEPATOPEXY

In hepatoptosis (mobile floating liver), partial or complete (Fig. [illegible])

Partial Hepatoptosis

Indirect Operations. (a) If the liver resembles a Riedel's lobe and is accompanied by a pathological gall bladder the latter should be given attention first.

(b) Hepatectomy. Excise the prolapsed lobe only when specifically indicated.

(c) Ventro-fixation. This consists of opening the abdomen over the most prominent part of the tumor. Attach the "dancing lobe" to the abdominal wall by means of several substantial catgut sutures. Scarify the surfaces to be opposed by vigorous friction with dry gauze before tying the sutures.

Kehr Operation

This is an adaptation of Rydygier's idea of splenopexy as applied to the anchoring of the partially ptosed liver.

Step 1. Make a horseshoe-shaped skin incision with its concavity directed upward, around the base of the mobile lobe. Extend the incision to, but not through, the transversalis fascia.

Step 2. Make a transverse incision through the transversalis fascia and peritoneum at the lowest point of the wound.

Step 3. Separate the transversalis fascia and peritoneum, together, from the superficial structures of the abdominal wall over a surface corresponding to the horseshoe-shaped incision.

Step 4. Make an incision through the fascia and peritoneum parallel to the lower transverse incision at the upper end of the loosened area. Secure the mobile lobe in the pocket of fascia and peritoneum thus formed. Suture the edges of the wound together.

Complete Hepatoptosis (Bonnet's operation)

Step 1. Expose the liver by making a vertical incision in the midline or along the external border of the right rectus abdominis muscle or one running parallel to the costal arch. Vertical incisions are preferred. If used [illegible], they can always be supplemented by a transverse incision.

Step 2. Return the liver to its normal position. If the liver is attached in its malposition by adhesions, sever them if possible without too much trauma. Have the assistant hold the liver in its corrected position while the surgeon proceeds with the following step.

Step 3. Insert coarse catgut or silk sutures through the parenchyma of the anterior margin of the liver taking a deep hold of the organ and also penetrating between the cartilages of the adjacent ribs. No harm resulted from the injury inflicted on the pleura during this procedure. Since the liver is very friable the sutures must be thick to avoid cutting it. The more sutures that are inserted, the less likely they are to cut through—from two to eight are used in practice. Some surgeons insert a few sutures between the liver and the upper end of the wound in the abdomen; others insert a few through the suspensory ligament (Lucas Championnière). If the liver cannot be successfully reduced, it should be sutured wherever possible so as to relieve distressing symptoms. Scarify the hepatic and parietal surfaces before placing sutures.

Step 4. Close the abdomen.

Hepatopexy and Laparorraphy

Depage's Operation

Depage strove to eliminate the laxity in the abdominal walls which he considered an important feature in favoring hepatoptosis.

Step 1. Make a horizontal incision from the tip of the eleventh rib on one side to the tip of the eleventh rib on the other side.

Step 2. Make an incision downward and inward to a point level with the umbilicus (Fig. [illegible]). AC is half as long as AB. Make an incision BD the same as AC. Make curved incisions CE and DE downwards to near the pubis. Remove all skin within the boundaries of the above incisions. Since stretching has resulted in widening of the linea alba, remove the linea alba with the peritoneum from the anterior or internal border of one rectus muscle to the internal margin of the other rectus muscle. Exert traction on the umbilical ligament of the liver and the inferior extremity of the falciform ligament. Pull these into the upper angle of the wound, shorten them and secure them there with sutures.

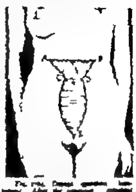


Fig. [illegible]. Depage operation. [illegible]. After the [illegible] (see text) [illegible] AC is [illegible] BD is [illegible] all [illegible] between CE and DE.

Step 3. Exercise great care in suturing the abdominal wound. Depage suggests suturing in planes as follows: (1) The peritoneum is sutured alone; (2) then the peritoneum and muscular planes are brought together; (3) the muscular plane alone; (4) the aponeurotic and muscular planes together; (5) the aponeurosis separately; (6) the skin and subcutaneous tissue together; the skin alone. A T-shaped scar results.

DIAGNOSTIC OPERATIONS

Abscess of the Liver

Diagnostic puncture of the liver to ascertain the position of a suspected accumulation of pus is a justifiable procedure as a means of diagnosis, not as a means of therapy.

Step 1. Cleanse the skin over the most prominent part of the swelling or suspected area.

Step 2. Introduce a sterilized aspirating needle in the ninth or tenth interspace, vertically below the angle of the scapula, and if no pus is struck, project the needle in various directions suspected of harboring the purulent accumulation.

Caution. According to Greig Smith "the movement of the needle following the

movements of the liver (if a abscess with suppuration) must not be checked, as thereby the liver tissue may be torn and permit escape of pus into the peritoneum."

Step 3. When pus is struck hepatotomy should at once be performed.

HEPATOTOMY

There are two routes which permit access to an abscess of the liver: (a) abdominal and (b) transpleural.

Abdominal Route

Step 1. Make a longitudinal incision over the most prominent part of the swelling.

Step 2. Enter the abdomen and examine the liver. If adhesions are found between the liver and the abdominal wall they must be preserved and not disturbed. If no adhesions have formed, isolate the field of operation with moist, warm, lap packs.

Step 3. Follow the needle within the abscess cavity (previously introduced for exploration and acting as a guide) with a pair of closed blunt-pointed forceps or with the electrocautery.

Step 4. Withdraw the aspirating needle.

Step 5. Guide the forefinger alongside the forceps into the abscess cavity for digital exploration.

Step 6. Wash out the abscess cavity with hot sterile saline solution followed by the introduction of a rubber tube or cigarette-type rubber tissue drains.

Step 7. Remove the lap packs. Cleanse the field of operation.

Step 8. Close the abdominal wall around the drain.

I do not recommend the introduction of a long sharp scalpel along the aspirating needle as practiced by some surgeons (Stromeyer Little). It carries many dangers. Blunt working is safest.

Keep in mind the possibility of multiple abscesses. (Jimenez (Mexico) 4 per cent. Zancarol (Egypt) 20 per cent. Legrand (Egypt) about 20 per cent.)

Transpleural Route

When the abscess is located in the back of the liver the abdominal route will be inadequate. By the time the abscess in the liver has reached a magnitude to permit of diagnosis, there already are present, in the majority of cases, (a) adhesions of the liver to the diaphragm, and (b) of the visceral to the parietal pleura. Thus, a comparatively safe route is created by Nature to reach the abscess cavity via the obliterated portion of the pleural cavity.

Step 1. Puncture. Place the patient on the sound side. Proceed to find the pus.

Step 2. Explore with an aspirating needle as outlined above.

Step 3. Do a costectomy (which one) of about 10 inches of the rib overlying the abscess (subperiosteal resection). Usually the segment of rib removed will correspond to the obliterated portion of the pleura, or it will be below the pleura. Should the pleura be inadvertently opened close it at once or protect it with lap packs.

Step 4. The diaphragm is now found lying exposed. Grasp it with forceps and incise it as in subphrenic abscess (Fig. [illegible]).

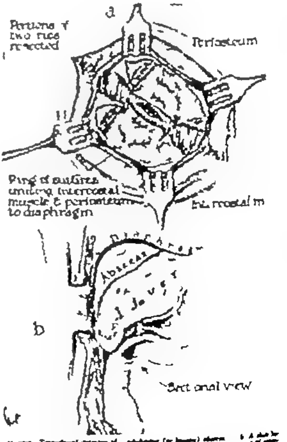


Fig. [illegible]. Transpleural drainage of an abscess of the liver. a. A skin [illegible] between the ribs has been made and short portions of two ribs resected. [illegible] suture bunds the periosteum, intercostal muscles and diaphragm to [illegible]. [illegible] the center of the ring and through the liver tissue [illegible] abscess.

Step 5. The liver now lies exposed; it is usually found adherent to the diaphragm. The aspirating needle, which remains in the abscess cavity, all the while acts as a guide to the abscess cavity, which is taken care of as outlined above.

Subphrenic Abscess

presents difficult problems from the diagnostic as well as from the therapeutic point of view. Bernard ... signs of pus somewhere, signs of pus nowhere else, signs of pus there ... depicts the situation aptly.

EXPLORATION FOR SUBPHRENIC ABSCESS

Gas-oxygen anesthesia preceded by morphine or scopolamine is used. The procedure should be practiced in the operating room and everything should be in readiness, if need be, for the drainage of the abscess when located. The needle should be of ample length and diameter. The position of the patient is the same as for empyema. Connect the aspirating needle with a properly functioning aspirating syringe. Introduce the needle in the tenth interspace in the scapular line. If no pus is encountered, withdraw the needle and reintroduce it into the ninth, eighth and seventh spaces. If the abscess is still not located, explore the same spaces in the midaxillary line from below upward. About 3 or 4 inches are traversed by the needle through which, while being slowly withdrawn, suction is made.

Signs that the Needle Has Entered the Subphrenic Space. (a) The sensation imparted to the fingers that two strata have been punctured (the pleura and diaphragm). (b) Fürbringer's sign. The barrel of the syringe will move with the respirations of the patient when the needle has passed the diaphragm. (c) Blood from the lung is frothy and bright red; from the liver it is dark. If all of these fail, open the abdomen and explore. There exists no abscess where one can introduce his hand freely between the diaphragm and the dome of the liver.

OPERATION FOR SUBPHRENIC ABSCESS

Transabdominal Route. Here the technic is the same as described above in connection with treatment of abscess of the liver (p. ...).

Transpleural Approach (Fig. ...). This also is similar to the description given above in dealing with abscess of the liver.

Comment. Alton Ochsner and Aman M. Graves[*] pointed out that the mortality rate in the cases they collected that were drained transpleurally was ... per cent, as contrasted with a mortality rate of ... per cent in those cases drained without contaminating the pleura or peritoneum. In a series of thirty-one cases they operated through a retroperitoneal approach to the subphrenic abscess the mortality was 9.7 per cent. They describe the retroperitoneal operation as follows.

RETROPERITONEAL OPERATION

Step 1. Paravertebral block anesthesia. Patient lying on the uninfected side on a kidney rest or bending producing ... of the lower dorsal and lumbar spine.

[*] ... operated in ... of subphrenic abscesses. Ochsner and Graves ... the needle ... pleura ... the pleura and peritoneum (needle introduced below the 12th rib and ... upward and forward).
Annals of Surgery, ...

Step 2. Make an incision over and parallel to the twelfth rib (Fig. 1726). Resect the entire twelfth rib subperiosteally. Avoid injury to the pleura which may be immediately beneath the rib (Fig. 1727).

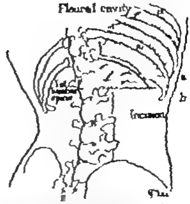


Fig. 1726. Diagrammatic drawing showing the incision made over and parallel to the twelfth rib and transverse incision through the lumbar fascia and diaphragm at the level of the first lumbar spinous process. (Ochsner and Graves.)

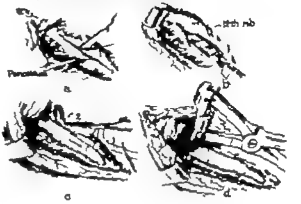


Fig. 1727. Subperiosteal resection of the twelfth rib throughout its entire length. (Ochsner and Graves.)

Step 3. Resect the entire length of the rib and make a transverse incision at right angles to the spine across the bed of the resected rib

at the level of the spinous process of the first lumbar vertebra (Fig. ...). It is extremely important that the incision through the bed of the rib be made transversely at this level and not parallel to the rib for only in this way can one be sure that the costophrenic angle of the pleura will not be injured. A transverse incision at the level of the spinous process of the first lumbar vertebra ... the pleura (Fig. ...). (Melnikoff.) This incision passes through the bed of the twelfth rib and the attachment of the diaphragm.

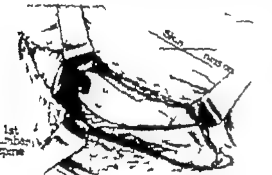


Fig. 1728. Drawing illustrating the ... incision made through the resected bed of the twelfth rib and the ... posterior inferior muscle ... the level of the spinous process of the first lumbar vertebra. ... Ochsner and Graves.

Step 4. After the diaphragm has been severed, the renal fascia is encountered (Fig. ...). This is continuous above and anteriorly with the posterior parietal peritoneum. Displace the kidney downward by means of the index finger. Palpate the subhepatic space. If indicated, exploration of the subhepatic space ... to determine the presence of suppuration. In cases where a right posterior-superior space abscess is suspected, the peritoneum on the under surface of the diaphragm can be readily separated from the diaphragm with the finger (Fig. ...). The inflammatory edema invariably present greatly facilitates ... of the diaphragmatic peritoneum from the under surface of the diaphragm. This separation may be carried upward as far as the dome of the liver and should be extended until the abscess is reached.

Step 5. Open the abscess cavity by means of the palpating finger by plunging the finger through the abscess wall which is adherent to the mobilized parietal peritoneum.

Step 6. Introduce large, soft, fenestrated rubber tubes into the abscess cavity and out through the wound. Through this incision adequate evacuation of abscesses located in the right posterior-superior, right retroperitoneal, the right inferior and even occasionally right anterior-superior spaces may be accomplished without traversing or contaminating either the pleural or peritoneal cavities.

Comment. The advantage of the retroperitoneal operation is exemplified by the results obtained by Ochsner in a total of thirty-one cases, nineteen of which were previously reported, of which three died, giving a mortality rate of 9.7 per cent. Two of the deaths were probably unavoidable as in each the patient died as the result of the original lesion, which in one was carcinoma of the stomach and in the other was typhoid fever. Abscesses located in the right anterior-superior, the right inferior, the left anterior-inferior and the left superior spaces can be drained extraperitoneally through the anterior abdominal wall. Obviously, however the anterior route of drainage would not be used in cases of right inferior space abscesses, if retroperitoneal drainage is employed, because these abscesses, Ochsner states, can be satisfactorily drained by the retroperitoneal approach.

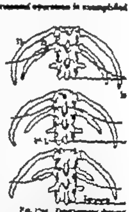


Fig. 1729. Diagrammatic drawings modified after Melnikoff, showing the variations in the relations of the costophrenic angle to the twelfth rib. It is evident that the transverse incision made at the level of the spinous process of the first lumbar vertebra will invariably miss the pleural reflection. (Ochsner and Graves.)

Clairmont pointed out that in right anterior superior and in left superior space infections with abscesses above the liver, the suppurating focus can be approached and drained extraperitoneally without contaminating uninvolved pleura or peritoneum.

Step 1. Make an incision just beneath and parallel to the costal margin through the flat abdominal muscles and transversalis fascia down to the anterior parietal peritoneum.

Step 2. As in the retroperitoneal operation, separate the parietal peritoneum from the under surface of the diaphragm with the index finger.

Step 3. Mobilize the peritoneum upward until the abscess cavity is reached.

Step 4. Open the abscess cavity extraperitoneally through the abscess wall which is intimately adherent to the mobilized parietal peritoneum. Drain with soft rubber tubes or sheets of rubber tissue brought out through the wound.

ECHINOCOCCUS CYSTS

Solitary Cyst

Because the cyst composed, like a tumor by ... or by ...

Multiple Cysts

These are treated as follows

Step 1. Aspirate through [illegible] cannula connected with [illegible] suction apparatus

Step 2. Open the cysts with an electrosurgical knife

Step 3. Sponge out the cyst contents cautiously avoiding implantations.

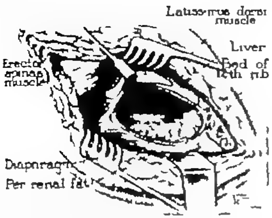


FIG. [illegible] Drawing illustrating the operative wound following [illegible] through the diaphragm at the level of the [illegible] process of the [illegible] lumbar vertebra exposing the [illegible] and the liver (Ochsner and Graves.)

Step 4. Pack the resultant cavity with iodoform gauze. Some cysts may be peeled out of the liver if not buried in dense adhesions. Above all, [illegible] is essential in these operations.

If the cysts cannot be removed, proceed as above and suture the edges of the opened cyst tightly to the edge of the abdominal incision. Close the rest of the abdominal wall. Introduce drainage tubes and pack.

Marsupialization

FIRST STAGE

(a) Deliver the cyst into the abdominal wound without puncturing it

(b) Pack gauze around it to form adhesions

SECOND STAGE

( ) Open the cyst after adhesions have formed. At no time should cyst fluid be permitted to escape into the peritoneal cavity. [illegible] and careful lap packing will usually succeed in effectively isolating the field of operation.

Comment: Harold Dew of Melbourne, Australia, in an admirable [illegible]

[illegible] on the subject writes that the incision should be one that gives most direct access to the cyst. Its position should be ascertained by clinical and radiographic studies. He recommends the vertical [illegible] incision. For cysts of the superior quadrants of the liver [illegible] transthoracic approach with costectomy as described above is recommended. Although Dew [illegible]

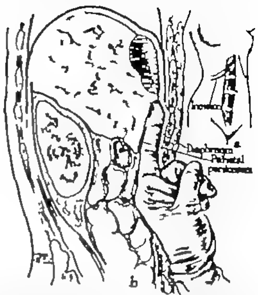


FIG. [illegible] Illustrations showing the method of draining [illegible] the right [illegible] space. As shown [illegible] [illegible] the [illegible] [illegible] the [illegible] muscles and the [illegible]. By means of the finger the parietal peritoneum [illegible] from the under surface of the diaphragm and the [illegible] cavity [illegible] reached. The abscess [illegible] then drained [illegible] without contaminating either the pleural or the peritoneal cavity. (Ochsner and Graves.)

that "since in these cases it is all important to avoid, if possible, opening the pleural cavity the incision should, therefore, be made as low down and as far forward as convenient. In some cases, however, owing to [illegible] of the costophrenic angle, the pleural cavity is opened. Suture of the diaphragm to the thoracic parietes may be desirable, but this is difficult to carry out effectively and, owing to the loss of support when the subjacent cyst is evacuated, the sutures often pull through, thus producing [illegible] sucking wound with its attendant risks."

[illegible]

In non-urgent cases Dew paints the serous surfaces with 5 per cent iodine solution. He uses [illegible] to enhance adhesion formation, after which (two or three weeks later) incision and evacuation of the cyst [illegible] carried out in the area between the adhesions, [illegible] endangering the pleural cavity with contamination and pneumothorax.

Wide retraction and thorough manual exploration are then done (both lobes of the liver, spleen and neighboring peritoneal folds are thoroughly scrutinized).

Thorough isolation of the field of operation is essential. Dew uses black packs for the layer of packs around the cyst "because daughter cysts and scolices show up well against this background."

A two-way syringe of special design is used by Dew which permits evacuation and injection of the hydatid cyst without removal of the needle (Fig. [illegible]). After evacuation of [illegible] sufficient quantity of fluid, pure commercial formalin [illegible] injected from [illegible] previously charged syringe without removing the needle. About [illegible] cc. of formalin [illegible] injected into [illegible] cyst about 10 cm. in diameter and allowed to act at least four minutes. The cyst is now opened and the fluid [illegible] evacuated

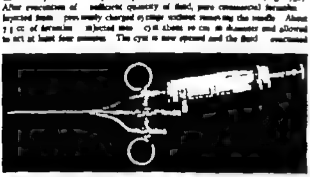


FIG. [illegible] Special two-way syringe which permits evacuation and injection of the hydatid cyst without removal of the needle. (Courtesy of Prof. Dew.)

with [illegible] suction pump. Solid contents that cannot be evacuated with the suction pump are removed with [illegible] spoon. The contents of the sac are evacuated thoroughly. The remaining cavity is swabbed out with [illegible] per cent formalin and 90 per cent alcohol. Dew admonishes again: no attempt should ever be made to remove the thick fibrous adventitia completely. Not only [illegible] that unnecessary but owing to the intimate connection between the adventitia and the hepatic connective tissue and the frequent presence of large vessels, such an ill-advised attempt is fraught with great danger and may be followed by [illegible] fatal result. In very large cysts partial removal of the extrahepatic portion of adventitia may however be carried out to facilitate [illegible] closure.

Treatment of the cavity is best shown by the appended diagrams (Fig. [illegible])

Liver Resection in Echinococcus Cysts

K. Tevlandtz ([illegible]) of Moscow, Russia, reported three cases of resection of the left lobe of the liver and two cases of excision of the right lobe of the liver for large echinococcus cysts. Thirty-nine further cases reported by Russian

surgeons show that the removal of encapsulated cysts is [illegible] comparatively simple procedure offering good prognosis.

HEPATECTOMY FOR TUMORS OF THE LIVER

A great portion of the liver can be removed without specific injury (Ponfick).

The two important factors in the removal of solid tumors of the liver are (a) proper [illegible] exposure and (b) hemostasis.

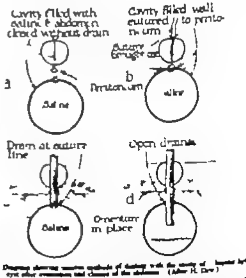


FIG. [illegible] Diagrams showing various methods of dealing with the cavity of [illegible] hepatic hydatid cyst after evacuation and closure of the abdomen. (After H. Dew.)

Tumors of the right lobe are best approached through transverse incisions (Mayo-Robson). Tumors of the left lobe may be effectively exposed through longitudinal incisions in the epigastrium or through transverse exposure. Tumors on the dome of the liver must be approached with the aid of costectomy. The position of the patient as described by Mayo-Robson (p. [illegible], Fig. [illegible]) is of distinct value.

Methods of Hemostasis During the Operation

Temporary elastic ligature. In pedicled tumors [illegible] rubber tube acting as tourniquet may be placed around the pedicle and the tumor removed. In tumors without [illegible] pedicle the liver substance behind the tumor is pierced with [illegible] cannula. A double elastic ligature is introduced through the cannula and the ends of the ligature are tied on either side of the tumor.

Pringle's Method of Digital Compression of the Portal Vein. In this procedure Langenbuch's suggestion was to divide the coronary and right lateral ligaments allowing the liver to be delivered and brought to the surface or make proper sized costochondral flap which is reflected upward. The Pringle maneuver consists of digital compression of the portal vein at the foramen of Winslow. Excellent temporary hemostasis is thus secured.

Auburtin's method consists of applying to the liver around the tumor to be removed a series of interlocked sutures of thick silk or catgut. A blunt needle with long curve is used in applying the sutures.

Kousnetzoff needles for liver suture may be used to advantage. I have devised an olive-pointed needle which can be used effectively and carried on the ordinary needleholder (Fig. 1734).

Each individual ligature after being crossed with its opposite fellow on the right and left is slowly and steadily tied with such firmness that the liver parenchyma is cut but the vessels remain in the undivided loop. When the whole series of ligatures is tied the tumor is removed with the knife or electrocautery. Little force is to be used in transfixing the liver. Obstacles are often encountered during the transit of the needle; these should be only touched by gentle traction and never be forcibly attacked, for these obstacles are generally caused by vessels and their transfixion may be followed by severe hemorrhage out of blood vessels and their [illegible] [illegible] instead of ligatures.

Interlocking gauze strips were used by Leonard Freeman instead of ligatures to secure hemostasis (1904). Freeman experienced difficulty in removing the gauze because the gauze knots cut into the liver substance. Later he made [illegible] his technic by securing the ends of the gauze strips with forceps or catgut.

Available Rules for Liver Resection

The incision through the liver substance should be made with sharp knife and the vessels picked up with forceps and ligated. If blunt force be used in dividing the liver substance, the hepatic vessels will retract giving rise to difficulties in securing and ligating them.

Wherever possible wedge-shaped piece of liver should be removed; this facilitates closure with sutures.

No special instruments for the introduction of the sutures is needed. The ligatures should be tied slowly but firmly.

3. The elastic ligature may be used in selected cases.
4. Tamponade is unnecessary after suture.
5. Division of the hepatic ligaments is frequently an aid in resection.
6. Do not hesitate to resect the right costal arch and to sever the temporary ligaments wherever access to the dome of the liver demands such exposure.

Kirschner surrounds the segment of the liver to be removed with overlapping sutures of catgut carried on a straight needle which traverses the whole thickness of the liver.

In view of the fact that liver tissue cuts through easily the interposition of the falciform ligament between the sutures and the liver will act as a bolster and prevent cutting through.

Bleeding vessels from the liver are after all best controlled by direct ligation of the respective vessels. When liver surfaces cannot be opposed by sutures

tamponade has to be resorted to. Fey and Martens (1903) recommend using gelatin plates to insure hemostasis after liver resections. These are cut into the desired shape and placed at the margin of the defect in the liver. Mattress sutures of strong catgut are passed through the plates and these approximated in such a manner that the defect in the liver is closed. In time the gelatin becomes absorbed. The plates should only be approximated and not too tightly drawn together.

Comment. Gerst points out that all complicated methods of suture of the liver are unnecessary and useless and that simple suturing and ligating properly carried out is all that is necessary to obtain excellent results.

Electrosurgery in Tumors of the Liver

Electrocutting currents, properly applied, divide the tissues and smaller vessels are sealed by coagulation.

Electrocoagulation permits destruction of localized tumors with no loss of blood. The tumor is coagulated in layers which are removed by the loop, layer after layer is coagulated until the whole mass is destroyed. Large tumors may be removed by electrocoagulation.

Primary Carcinoma of the Liver

Dr. Reginald H. Jackson summarizes the subject of primary carcinoma of the Liver as follows (Fig. 1735):

Fig. 1734. Author olive pointed needles.

Primary carcinoma of the liver is very rare lesion, of especially great interest to pathologists and of increasing importance to surgeons. A cursory review of the available literature reveals such an extremely paucity of cases subjected to surgical treatment that it is my duty to report an authentic case (Hepatoma type). The patient, a white woman, aged eighty years, whose chief and practically only complaint was the presence of a large spherical, cystic tumor, was subjected to exploratory laparotomy for a probable pancreatic cyst. Operation revealed a globular tumor mass occupying nearly the whole of the left lobe of the liver. No primary source of malignancy present. Physical conditions of growth were such as to invite left hepatic lobectomy. A primary step in the operation was the ligation of the left hepatic artery and the left portal vein. This procedure effectively solved the problem of serious hemorrhage during or after the operation of left lobectomy and greatly lessened the chance of postoperative leakage of bile.

Embryologic and phylogenetic development of the liver indicate that there should be little or no cross-circulation of blood or bile between the right and left lobes of the liver. McIndoe and Counseller have shown clearly that such is, indeed, the case in the human. It would, therefore, seem expedient in certain cases of neoplasms of the left lobe to perform partial lobectomy in preference to local excision, to ensure

1. Extensive radical removal of neoplastic tissues
2. Prevention of severe hemorrhage during or after operation
3. Prevention of postoperative leakage of bile
4. Practically primary closure of abdominal wound

"The operation was made under spinal anesthesia, without any alarming symptoms during or after its performance. Convalescence was uneventful and the patient is now fourteen months later enjoying excellent health."

SURGICAL TREATMENT OF ASCITES DUE TO CIRRHOSIS OF THE LIVER

Epiploopexy

According to Bunge (1903) the Talma-Morison operation is indicated in:

1. Atrophic Cirrhosis of the Liver
2. Cirrhosis due to Cardiac Disease
3. Pseudocirrhosis with Chronic Pericarditis
4. Chronic Hyperplastic Perihepatitis
5. Rarely in Portal Stenosis due to Thrombosis

The operation is serious. I had some good results from its use and experienced many failures.

There are certain contraindications to the performance of epiploopexy. Some of these are: (a) advanced age, (b) marked cholemia, (c) advanced debility or arteriosclerosis, and (d) chronic interstitial nephritis.

Patients usually succumb in a condition of coma within a few days of operation in the presence of the contraindications cited.

Drummond in 1896, and Talma in 1898 independently suggested epiploopexy in the treatment of ascites due to cirrhosis of the liver. The object was to establish connections between branches of the epigastric veins and the branches of the portal vein. A portion of the blood of the portal vein then finds its way through the new avenues created, operatively, into the inferior vena cava. Kusnetzoff, Ito and Omi established the feasibility of this procedure by numerous experimental studies on animals.

The great omentum is usually used in the operation. Korte objects to Morison's operation (omentopexy combined with abdominal drainage) warning of the possibility of infection from this procedure.

Direct anastomosis between the portal vein and the vena cava, or Eck fistula, was suggested by Eck's experiments on animals. Tiera proposed using this method in man. It was first performed by Vidal, with disappointing results. Rosenstein (1911) has had some success with the operation. "This operation, writes Gibbs, "ought to be abandoned, because however effectual it may be, it exposes the patients to two great dangers—the danger of elementary intoxication which might possibly be foreseen and avoided, but specially the danger of general infection of intestinal origin seeing that the intestinal mucosa does not always oppose a sufficient barrier to microbic invasion." Vidal's patient died four months after the operation and a patient operated on by Thierry de Martel succumbed to sepsis in 48 hours. Villard and Tavernier joined the mesenteric to the right ovarian vein, the stoma, however became occluded by a clot.

TALMA-MORISON OPERATION

Step 1. Local, spinal, nitrous-oxide-oxygen or ethylene anesthesia. The abdomen is opened in the median line to the right also, the umbilicus. A suction apparatus evacuates the fluid from the free abdominal cavity as well as the pelvis and renal pouches. Gauze mops are used in the absence of suction apparatus.

Step 2. Expose as much of the upper surface of the liver as possible and with gauze sponge rub it vigorously in all its accessible parts. Treat the spleen similarly.

Step 3. Deliver the omentum into the wound. Rub it with a gauze sponge until it bleeds slightly. Unite it to the parietal peritoneum which has been scarified to the extent of the palm of the hand in the following manner. Evert the abdominal wall, which is now flaccid as a result of the released ascitic fluid. Expose the parietal peritoneum as far from the midline as convenient. The omentum is sutured to the parietal peritoneum with catgut sutures as far from the midline as possible. The same procedure is practiced on both sides (Fig. 1736).

Step 4. Close the abdominal wall in layers.

Fig. 1735. A spherical growth almost [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]. Removed by Dr. [illegible] [illegible] [illegible] (Dr. R. Jackson.) [illegible] [illegible] primary liver-cell carcinoma.

As already pointed out, the use of drainage tubes above the pubes as in the earlier operations has been abandoned by most surgeons as unnecessary and being a possible source of infection.

Generally the best results from this operation are obtained the earlier the patient submits to the operation. The postoperative mortality is about 20 per cent (Monprofit).

Schiassi's operation consists of suturing the omentum between the layers of the abdominal wall (intramural epiploopexy). The results are no better than with the Talma-Morison procedure described above.

Paracentesis Abdominis

The bowels and bladder should be empty.

Step 1. Cleanse the abdomen. Put the patient in a sitting position. If too weak he is set up propped dorsal decubitus. Choose the puncture point in the linea alba, at a midpoint between the umbilicus and pubes.

Step 2. Deposit a small quantity of 1 or 2 per cent novocaine solution intra- and subdermally at the proposed point of puncture.

Step 3. Penetrate the abdominal wall gently and firmly with trocar and cannula.

Step 4. Withdraw the cannula.

Step 5. Permit the ascitic fluid to escape slowly. If the patient complains of faintness during the paracentesis, plug the cannula, thus stopping the escape of fluid until he recovers. If the patient be seated in a small [illegible] chair and if syncope should supervene the patient can easily be tipped quickly into

FIG. [illegible]. Epiploopexy (Talma-Morison operation). [illegible]

a recumbent position. After fluid of sufficient quantity has escaped, the cannula is withdrawn.

Step 6. Apply a dressing over the puncture point and apply a tight fitting abdominal binder.

Precautions. Avoid puncturing a distended bladder or the uterus. A [illegible] may inflict injury to the bowel. If fibrin obstructs the cannula, clear it with a probe. Avoid too large [illegible] trocars. A smaller instrument is preferable; it prevents the rapid egress of fluids.

Permanent Abdominal Drainage

Many methods to drain the peritoneal cavity permanently have been advocated from time to time. These consist of diverting the fluid into the subcutaneous cellular tissues by means of chemically hardened vessels, silver wire bridges, bundles of silk, glass tubes, etc. It is doubtful, however, whether the hoped for results for these methods will materialize. They are temporary measures at best. However Kalb's method of subcutaneous drainage is said to have given satisfactory results. It consists of forming a wide connection between

the abdominal cavity and the subcutaneous connective tissue so that the fluid constantly being formed leaves the abdomen, is absorbed as in continuous hypodermoclysis. Narath refers to this procedure as window drainage.

Step 1. Place the patient in the Trendelenburg position and elevate the side of the patient which is opposite the surgeon.

Step 2. Open the abdominal cavity by a median incision a little more below than above the umbilicus.

Step 3. Remove the ascitic fluid completely.

Step 4. Retract forcibly the side of the abdominal wound opposite the surgeon.

Step 5. While the intestines are held back, or if need be, after eventrating the intestines, cut a window opening the size of the palm of the hand through the abdominal wall from within, with the exception of the skin. This is best done with the electrosurgical knife. The external muscle fascia must also be removed so that the subcutaneous fat and the [illegible] skin are the only structures between the abdominal cavity and the exterior. Avoid injuring the skin by placing the left hand on the outside of the endangered area. If visibility is impaired by adhesions, caution is necessary to avoid injuring the ascending colon on the right side and the descending colon on the left. As a rule, the muscle wound bleeds quite freely.

Step 6. Hemostasis may be difficult in the abdominal window which is hard to get at and under such circumstances control bleeding with a running suture.

Step 7. Close the median incision without drainage.

Comment. In a short time the skin over the window bulges [illegible] and the neighboring tissues become infiltrated with fluid. The edema may spread and lead to a marked swelling of the scrotum or the labia majora. The more marked and more prolonged such edema, the better the result of the operation which may also be performed on both sides.

IMPLANTATION OF THE SUPERIOR MESENTERIC VEIN INTO THE INFERIOR VENA CAVA (ROGERS'S OPERATION)

Rogers described this procedure in 1913. It consists of dividing the superior mesenteric vein at the lower end of the mesentery and implanting its distal (distal end) into the inferior vena cava.

Step 1. Enter the abdomen through a right pararectus incision about 6 inches in length beginning about 3 inches above the level of the umbilicus.

Step 2. Evacuate the ascitic fluid.

Step 3. Bring the terminal portion of the ileum out of the abdominal cavity and expose the terminal mesentery. Locate and isolate the superior mesenteric vein for about a distance of [illegible] inches. The vein lies close to the superior mesenteric artery. Place a ligature at the proximal end of the exposed vein. Be careful to leave a number of veins proximal to the point of ligature to avoid diverting the whole supply of blood of the small intestine from the portal circulation.

Step 4. Place a clamp on the superior mesenteric vein a couple of inches distal from the ligature. Divide the vein close to the ligature.

Step 5. Replace the bowels into the abdominal cavity and permit the vein to hang free upon the lower surface of the mesentery.

Step 6. Incise the parietal peritoneum of the posterior abdominal wall in front of the inferior vena cava. Expose the anterior wall of the inferior vena cava for a distance of about [illegible] inches.

Step 7. Grasp the anterior wall of the inferior vena cava with a blood vessel clamp in the long axis of the vein.

Step 8. Make a small opening in the vein held by the forceps.

Step 9. Place 4 mattress sutures [illegible] from one another and unite the circumference of the open end of the superior mesenteric vein with the opening created in the inferior vena cava. The sutures must penetrate the entire thickness of both vessels to be united and their ends are left long.

Step 10. Place a row of continuous sutures between each of the two sutures left long which act as traction sutures. Avoid undue strong action or constriction.

Step 11. Close the incision made in the parietal peritoneum of the abdominal wall.

Step 12. Close the abdomen in the usual manner.

IMPLANTATION OF THE SAPHENOUS VEIN INTO THE PERITONEAL CAVITY (RUOTTE OPERATION)

Ruotte described this procedure in 1907. The operation consists of implanting the large saphenous vein into the peritoneum, [illegible] the object being to have the saphenous vein gather the ascitic fluid and direct it to the femoral vein and hence to the general venous circulation. The return flow of blood from the femoral vein into the free peritoneal cavity is prevented by the valves in the vein.

Step 1. Expose the long saphenous vein on the anterior surface of the thigh through an incision placed about [illegible] lateral to the pubic spine and [illegible] below it. Carry the incision downward and slightly laterally for a distance of about 10 cm.

Step 2. Expose the long saphenous vein and divide it at a distance of about 10 cm from the femoral vein. Ligate its distal end.

Step 3. Make an incision in the anterior abdominal wall a little above Poupart's ligament to the extent of about 3 cm. Divide the peritoneum for [illegible] cm only. Aspirate the ascitic fluid. Create a subcutaneous tunnel between the upper and lower skin incisions.

Step 4. Bring the long saphenous vein connected with the femoral through the tunnel. Bevel the edges of the vein and suture the margins of the open peritoneum to the open end of the vein. [illegible] anastomosis thus formed between the peritoneal cavity and the venous circulation.

Step 5. Close the wound without drainage.

Comment. Successes are reported from this method by some authors while others reported failures (occlusion of the anastomosis, obliteration of the saphenous vein).

OPERATIONS ON THE GALLBLADDER

Historical Notes. Gallstones have first been noted [illegible] as mentioned by Gentile da Foligno about [illegible]. Marcellus Donatus [illegible] [illegible]. He described an incarcerated stone in the [illegible]. While Fabricius Hildanus removed gallstones from [illegible]

[illegible] believe that this operation was performed on the dead. The first attempt at the removal of biliary calculi from the living are found in the writings of [illegible] (1667), [illegible] (1734) and [illegible]. However these procedures were not deliberate [illegible] to other operations. To Jean Louis Petit [illegible] belongs the credit of deliberate planning and carrying out the removal of stones from the gallbladder.

Thudichum [illegible] proposed cholecystostomy in two stages. To Bobbs (1867), an American surgeon, belongs the credit of having done the first cholecystostomy in one stage. However he did not plan the operation deliberately, for at operation he thought he was dealing with an ovarian tumor. The first successful cholecystostomy was performed by [illegible]. Lawson Tait, Kocher and others soon followed.

The first successful cholecystectomy was done by Langenbuch in 1882. [illegible] French surgeons [illegible] and [illegible] were first to report Langenbuch's success. It took several years before [illegible] accepted the procedure as worth while, Lawson Tait [illegible]. Cholecystenterostomy was performed at the suggestion of [illegible] by von Winiwarter in [illegible]. The anastomosis was made between the gallbladder and the transverse colon. [illegible] experiments carried out by [illegible] resulted in his pointing out that the duodenum, in all events of union, would be much preferable because of [illegible] the colon which are sure to follow.

Choledochotomy [illegible] procedure was first performed by [illegible].

Langenbuch suggested to [illegible] (1884) the feasibility of [illegible] choledochotomy. The operation proved [illegible]. [illegible] and others [illegible] performed the operation successfully. [illegible] the duodenum with [illegible] choledochotomy was introduced by [illegible]. Transduodenal choledochotomy was done by Kocher in [illegible] and choledochotomy by McBurney in [illegible].

Choledocho[illegible]ostomy was devised by [illegible] in [illegible]. The first successful performance of this operation [illegible] credited to [illegible] in [illegible].

[illegible] valuable contributions to biliary surgery which lead to its present perfection were made by [illegible], Lord Moynihan, the brothers Mayo, Mayo-Robson, [illegible] and others.

Anatomical Considerations. The gallbladder [illegible] divided into fundus, body and neck. The cystic duct is located in a peritoneal fold and runs from the neck of the gallbladder to the lower [illegible] and opens into the right side of the hepatic duct at an acute angle. Its mucosa [illegible] projects into the lumen in [illegible] of the spiral ridge, known as the valve of Heister. It is this valvular arrangement of the [illegible] that often prevents the passage of a probe into the common duct. The cystic artery accompanies the duct, usually on the left side.

The common hepatic duct [illegible] formed in the depth of the [illegible] by the union of the right and left hepatic ducts. It [illegible] in the right free margin of the lesser omentum for about [illegible] and after joining the cystic duct [illegible] the common bile duct which is about [illegible] cm long. It is divided into four parts: (a) supraduodenal portion, (b) retroduodenal portion, (c) pancreatic part and (d) intraduodenal portion. It runs along the right free margin of the [illegible] in front of the foramen of Winslow with the portal vein and the hepatic artery to its left. It descends behind the first part of the duodenum and then [illegible] the posterior surface of the head of the pancreas, the superior [illegible] to its left and in close association with the inferior vena cava. It then passes [illegible] the internal border of the second part of the duodenum. Here it is crossed by the [illegible] pancreaticoduodenal artery. It then unites with the pancreatic duct (duct of Wirsung) forming the ampulla of Vater and finally opens at the top of the papilla in the second part of the duodenum.

The ampulla of the common duct is surrounded by the sphincter of Oddi [illegible] a layer of [illegible] muscle fibers. It is of importance to recall that when the gallbladder contracts the sphincter of Oddi relaxes ([illegible]). A number of [illegible] are [illegible] along the course of the common bile duct in close relation to its walls. [illegible]

or two of these are found near the termination of the cystic duct and several are found between the duodenum and head of the pancreas.

Often these nodes become enlarged and give the surgeon an impression during palpation of being gallstones. In obstruction the common duct may dilate to enormous dimensions. Cases are recorded in which it has been found the size of an adult small intestine.

Comment. It is important to remember in discussing the surgical significance of anomalies of the extrahepatic biliary passages and blood supply that practically all accidents to the ducts and vessels occur during the operation of cholecystectomy with or without choledochotomy; and, since cholecystectomy has in many instances displaced cholecystostomy, it is obviously the duty of every surgeon to make himself familiar with the normal anatomy of these parts.

It is customary for several reasons, to begin the removal of the gallbladder at the cystic duct and it is here that all the traps lie. There is only one way to avoid catastrophe, that is, to hit the neck of the gallbladder with a clamp, and after cutting through the gastrohepatic ligament near that point, to wipe the fatty tissue gently toward the common duct. The cystic duct and artery now usually come into view and can often be separately secured. If there should be an accessory artery or duct it will be exposed to view before being divided, and the junction of the cystic duct with the common duct can be seen distinctly. There are some cases, however, in which the tissues are deformed, thickened, and contracted by inflammation, so that it is not possible to obtain a truly clear definition. It is in this type of case that the most expert surgeons have, probably, all had unhappy experiences.

Secondary operations on gallbladder cases have to be performed much too often, for I venture to say that ninety-nine out of one hundred could be avoided by a proper definition of the parts at the original operation, combined with a better knowledge of the pathology of the gallbladder.

Flint believes that the accessory ducts are injured as frequently as the common duct, if not more often. He has seen an accessory duct three times at operation during identification of the structures in the region of the cystic duct preliminary to clamping it. In one of his cases he saw bile coming from an opened duct and thought he had divided the common bile duct, but on investigation this structure appeared to be intact.

GENERAL REMARKS

Position of the Patient on the Operating Table. This is important. The rest, or cushion or body elevator to be found on most modern operating tables will, when properly placed, project the spine forward and, with it, the liver and bile passages, bringing the latter several inches nearer the surface. The lower thorax and upper abdomen is raised and the feet of the patient lowered 5 or 6 inches (Fig. 1727).

Anesthesia. Where no contra-indications exist, spinal anesthesia has much to recommend it.

Incision. A variety of incisions have been advocated for the exposure of the gallbladder and biliary passages (Kehr, Kocher, Mayo-Robson, Bevan, Kling, Rutherford Morison, Sprengel and others). I restrict my work to a right vertical transrectus incision near the midline beginning at the costal margin.

Karl Meyer and Willard Bartlett are proponents of the transverse incision. Both have its advantages as does Hamilton Bailey.* I open the anterior sheath of the rectus abdominis muscle and incise it longitudinally; the muscle is retracted outward and the posterior sheath of the rectus abdominis muscle and the peritoneum are opened (Fig. 1728). By retracting the muscle outward the nerve supply is safeguarded.

[illegible] "It [illegible] often wiser to lay bare the common bile duct than the cystic duct" (Dr. Fell Flint).

Exploration. Pack off the operative field, with meticulous care. A lap sponge wrung out of salt solution of proper temperature is placed in Morison's pouch; a second pack is introduced medially to keep the stomach out of the way; a third lap sponge pushes the structures below (colon, etc.) out of the field of operation. Good retractors are of value in securing good exposure. St. Jacques' abdominal retractor is of distinct aid.

Delivery of the Liver. Free the liver and gallbladder from existing adhesions. This sometimes is accomplished with facility. At other times it is an

Fig. 1727. Fig. 1728.

Fig. 1727. Mayo-Robson position.

Fig. 1728. Incision to expose biliary passages. Mayo-Robson position. The dotted line shows the direction in which Mayo-Robson extends the incision when he finds it necessary to expose the common bile duct. Incision used by the author by preference. It [illegible] begins at the lower costal margin and extends vertically downward to a point opposite the umbilicus.

exceedingly difficult task and should be practiced with deliberation and utmost care lest injury to the adjacent viscera results.

By grasping and lifting the lower border of the liver from under the shelter of the costal arch, after first drawing the organ downward with the hand protected with a lap sponge, the extrahepatic biliary passages are often brought quite close to the surface. When the patient is stout the vertical incision may have to be prolonged in an upward and downward direction to effect such rotation and delivery of the liver. In thin individuals this may be accomplished with facility and instead of the gallbladder and cystic duct forming an angle with the common duct, the direction from the fundus of the gallbladder to the termination of the common duct will be a straight one. "In complete," writes Mayo-Robson, "is the exposure that, if needful, the peritoneum can be incised over the free border of the lesser omentum and the common duct separated from the hepatic artery and portal vein, though this is not necessary except when a growth has to be excised. The surgeon, whose hands are both free, can now deal with the

* Of late the author adopted the transverse incision advocated by Hamilton Bailey (Transactions of the International College of Surgeons, vol. [illegible], October 1938) with excellent results.

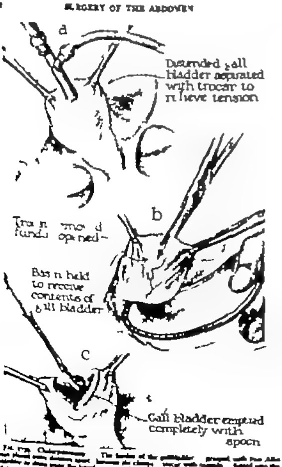


Fig. 1729. Cholecystostomy. The fundus of the gallbladder [illegible] grasped with two Allis clamps [illegible] [illegible] the clamps [illegible] The contents [illegible] the gallbladder [illegible] spoon the gallbladder [illegible]

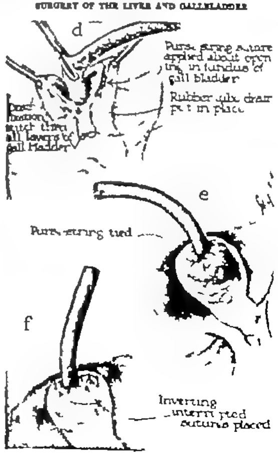


Fig. 1729 (continued). Cholecystostomy. d. [illegible] Steps showing drainage and closure [illegible] purse string suture and interrupted sutures are placed to invaginate fundus of the gallbladder about the drain.

gallbladder and cystic, common and hepatic ducts quite easily and it is safe to affirm that there is no portion of the gallbladder, cystic, common or primary division of the hepatic ducts which cannot under ordinary circumstances be reached for the removal of the concretions.

The beginner will do well to remember that successful operating on the biliary passages can be done only after years of experience.

Hemostasis must be meticulous. Every bleeding point should be ligated.

Preoperative study of liver function while not on definitely established basis as yet, is, nevertheless, of great aid in forestalling possible calamities such as so-called "liver-deaths." The galactose and urobilin tests have thus far proved to be the most reliable.

Abdominal Closure. It is well to recall that immediately upon completion of the operation the strained abdominal position must be relieved by removing the bolster, deflating the air cushion or lowering the body elevator. Otherwise difficulties will be encountered in closing the abdominal wall by reason of tension on the tissues of the abdominal wall which are now to be united in layers. In stout individuals or where there is reason to believe that the tension on the sutures will be excessive, tension sutures should supplement the others.

CHOLECYSTOTOMY (CHOLECYSTENDYSIS) AND CHOLECYSTOSTOMY

By cholecystotomy is understood the opening of the gallbladder for the removal of a solitary stone, perhaps, and closing the opening thus made by suturing it. Our predecessors in surgery spoke of "ideal cholecystotomy" as referring to this operation. It is seldom practiced nowadays. It is of historical interest only. It was first performed by Meredith (1883). Cholecystostomy on the other hand, consists of the creation of a stoma in the gallbladder for the purpose of removing calculi and establishing drainage (Fig. 1739).

Indications for Cholecystostomy

1. Calculi in the gallbladder, cystic duct and supraduodenal portion of the common duct.
2. Chronic inflammation of the extrahepatic biliary passages which has resisted medical régime.
3. Empyema of the gallbladder and acute inflammations of every variety.
4. Certain forms of jaundice occasioned by inflammation of the head of the pancreas compressing the bile ducts, when for some reason or another cholecystenterostomy is inadvisable.
5. As a palliative measure in certain types of carcinoma of the common duct or the head of the pancreas.
6. Perforations due to trauma or disease.
7. Gangrene of the gallbladder where the condition of the patient is precarious.

Step 1. Expose, isolate (packs) and explore the gallbladder and extrahepatic biliary passages as described above. A large tense gallbladder may first be reduced in size by aspiration (Fig. 1739a) after steadying the viscus with Allis forceps placed on either side of the fundus of the gallbladder.

Step 2. Enlarge the opening made by the aspirator with scalpel or scissors (Fig. 1739b).

Release the Allis forceps steadying the fundus and with them grasp the edges of the opening created by the scissors. If stones are found they are removed with a scoop (Figs. 1739c–1740).

A gallbladder sponge (see Fig. 1764) pressed against the external surface of the gallbladder near its neck will effectively catch the overflow of bile and calculi. Introduce long narrow strips of gauze into the opened gallbladder. These will absorb the accumulated bile and will render the interior of the gallbladder temporarily dry. Small stones will often be found caught in the meshes of the gauze strip when it is quickly removed from the gallbladder. Again explore the interior of the opened viscus and ascertain the patency of the biliary passages. Temporarily close the opening in the fundus of the gallbladder by an artery forceps. Introduce the hand into the abdominal cavity and explore, by palpation, the exterior of the extrahepatic biliary passages for stones (through the foramen of Winslow). If concretions are found arrested in the bile ducts an attempt should be made to disengage them by "milking" them back into the opened gallbladder whence they are promptly removed. Heister's valve will frequently prevent the introduction of the exploring sound. If so, do not force passage. Leave well enough alone.

Fig. 1740. Gall stone scoop.

Step 3. Introduction of the drainage tube. A de Pezzer catheter No. 30 may be used to advantage by introducing its head into the gallbladder and suturing the inverted edges of the gallbladder snugly but not tightly around it. (Purse string or interrupted sutures); or a rubber tube of proper caliber or a catheter (No. 3 Jacques) may be used instead of the de Pezzer catheter. The tube is first fastened to the edge of the opening in the gallbladder by two catgut sutures which embrace all the coats of the gallbladder wall.

Place one or two purse string sutures of No. 1 chromic catgut around the tube, inverting the gallbladder toward its interior as the tube is depressed while tying the purse string suture in a manner similar to that of doing a Kader gastrostomy (Fig. 1791d, e, f). Do not attach the fundus of the gallbladder to the parietal peritoneum.

Step 4. If need be, a cigarette drain may be introduced into Morison's pouch and brought out through the anterior abdominal wound.

The late Albert J. Ochsner omitted in many cases the use of rubber tubes entirely. Instead, he filled the gallbladder with narrow strips of gauze permitting them to emerge from the wound. The gallbladder edges were sutured all around to the parietal peritoneum and transversalis fascia. The general peritoneal cavity was thus effectively shut off. The packing is removed three days after the operation. In about a fortnight or three weeks the fistulous tract closes.

Step 5. Remove the lap packs. Allow the gallbladder to recede to its normal position. Close the abdominal wall in layers. Attach the tube leading from

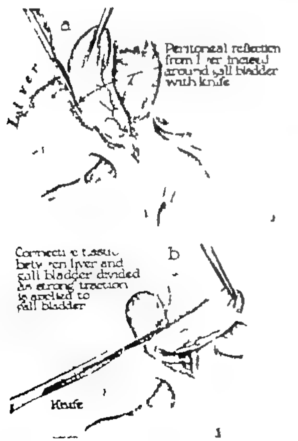


Fig. 1741. Cholecystectomy. Removal of the gall bladder from the direction of the fundus toward the cystic duct. a, the peritoneal attachment of the gall bladder to the liver is divided; b, division of connective tissue attachment between gall bladder and the liver bed.

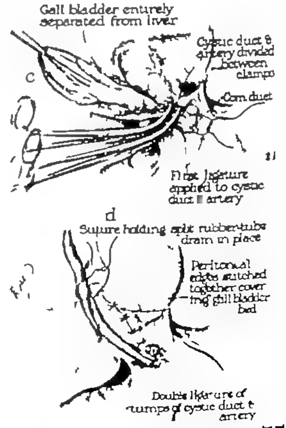


Fig. 1742. Cholecystectomy (continued). c, Double clamping for division of the cystic duct and artery. d, The gallbladder bed covered by suturing the peritoneal flaps. Drain in place.

the gallbladder to [illegible] receptacle attached, by adhesive plaster to the side of the patient.

CHOLECYSTECTOMY

Indications

Tumors (carcinoma, etc.)
Contracted gallbladder
2 Hydrops and hypertrophy of the gallbladder.
Some cases of gangrenous or phlegmonous cholecystitis.
3 Empyema of the gallbladder (some cases).
4. Degenerative changes (incrustations)
7 Fistulae [illegible] trauma (gunshot and other wounds)
8 Cholelithiasis.

This operation may be performed from above downward or from below upward. Incision, position of patient, etc. are the same as in the previous operation.

Step [illegible] Isolate and divide the falciform ligament. Traction on this structure will aid to better expose the extrahepatic biliary passages. If adhesions prevent proper exposure, they must be divided. A clear view of the operative field [illegible]. Moynihan's maneuver of delivery of the liver may sometimes be of aid. It consists of seizing the edge of the liver with gauze and gently dragging it down from its shelter beneath the costal arch and bringing it out of the wound by [illegible] rotating movement. This, however, is not always possible.

Step [illegible] Isolate the cholecystoduodenocolic and hepatoduodenal ligaments. Be thoroughly familiar with the surgical anatomy of the parts (see above). Isolate and visualize the extrahepatic biliary passages. Upon this step the success or failure of the operation frequently depends. If inflammatory adhesions surround the parts, dissect them away. Isolate the field of operation by properly placed lap-packs. A good self-retaining retractor here renders excellent service. Additional retractors may be used when needed, keeping in mind, however, to get along with as simple an armamentarium as is consistent with good work.

Step 3. Grasp the fundus of the gallbladder with [illegible] pair of forceps. With another pair engage Hartmann's pouch (Fig. [illegible]) (Moynihan gallbladder forceps). Traction on the latter will expose the region of the cystic duct. The next important task is to identify and visualize the biliary passages. In view of the fact that variations in the arrangement of the bile duct and arterial supply occur in about [illegible] per cent of cases (Flint) [illegible] is apparent how important it is to see the structures concerned before subjecting them to surgical manipulations. Dissect out the cystic duct. Occasionally Hartmann's pouch overhangs, and is intimately adherent to, the common duct, in which event they should be separated by gentle dissection. Blunt longitudinal separation of the fat and cellular tissue about the cystic duct will bring the structure to view. By working from the neck of the gallbladder downward or from the duct upward the continuity of these is established (Fig. [illegible])

Step 4. Pass [illegible] curved artery forceps behind the cleared cystic duct. Open and spread the forceps behind the duct. Throw [illegible] chromic catgut ligature around the cystic duct and artery simultaneously. Tie them together but do not crush them. Excessive force applied here may cause the ligature to cut through and predispose to biliary leakage. For safety place two ligatures about [illegible] cm from one another. Grasp the proximal portion of the cystic duct with another forceps and divide the duct with scalpel or scissors. Touch the divided ends with carbolic acid or iodine (Fig. [illegible])

Caution. Before applying the ligature to the cystic duct make sure that [illegible] is sufficiently separated from the common duct, thus avoiding injury to the latter.

Step 5. Dissect the gallbladder by sharp dissection from its bed, keeping constantly in mind to avoid injury to the bed of the gallbladder. A strip of peritoneum should be permitted to remain on either side of the ablated gallbladder to facilitate proper closure of and protection of the gallbladder bed.

Step 6. A continuous or interrupted catgut suture closes the defect in the gallbladder bed by bringing the edges of the peritoneum together. Do not puncture the liver tissue while passing the needle in approximating the peritoneal edges (Fig. [illegible])

Drainage is often omitted by many surgeons. In classical cholecystectomy I prefer to use what Lord Moynihan so aptly described as "conscience drain." It can do no harm and may avert disaster in case of unexpected biliary leakage (Fig. [illegible]) (See author's operation, p. [illegible])

Subserous Cholecystectomy

This was described by Witzel in [illegible]

Step 1. Incise the serosa on the surface of the gallbladder beginning at the fundus and extending to the cystic duct on both sides.

Step 2. Find the line of cleavage between the serosa and muscularis and separate the former from the latter along the line of incision shelling out the gallbladder from its serous covering.

Step 3. Clamp the cystic duct. Ligate it. Unite the serous leaflets with catgut sutures.

Comment. This operation can only be done in the minority of cases. The majority of gallbladders coming for operation are so altered by pathologic changes that to perform [illegible] subserous enucleation is very often an impossibility.

Moses Behrend[1] justly stresses the pertinent factors in reduced mortality in cholecystectomy in which he points out the important rôle played by spinal anesthesia, the administration of glucose by venoclysis and hypodermoclysis, as well as the proper selection of cases. His conclusions are pertinent and follow:

1. An accurate knowledge of the anatomy and special anatomy of the bile passageways.

2. Spinal anesthesia, because of the relaxation it affords, has greatly reduced the mortality.

[1] American Journal of Digestive Diseases and Nutrition, Vol. [illegible], No. [illegible] March, [illegible].

3. Glucose and blood transfusions before and after operations are of great value.

Do not operate as an emergency on acute cases.

5. Put the stomach and intestinal tract at absolute rest.

6. Do not explore the common duct unless there is some very good reason.

7. The less we increase drainage, at operation, the better.

8. Never perform [illegible] cholecystostomy in the presence of jaundice.

9. Whenever possible remove the gallbladder within its peritoneal fold.

Fig. [illegible] Bile ducts [illegible] the gall bladder bed

ELECTROSURGICAL OBLITERATION OF THE GALLBLADDER

Cholecystoelectrocoagulectomy

Author' Operation

Rationale. In selected, uncomplicated cases the removal of the gallbladder with the scalpel yields [illegible] mortality of [illegible] per cent and in the hands of those not especially trained, particularly in patients over forty years of age with coexistent hepatic and cardiorenal disease the mortality is [illegible] per cent or even higher. Mortality advances rapidly with age. It [illegible] much greater in males than in females. This is explained by Thorek on an anatomic basis, [illegible] narrower configuration of the lower male thorax and consequent inaccessibility of the structures as compared with females.

Fatalities following classical cholecystectomy are caused by the following factors:

In [illegible] per cent of individuals there are enlarged bile capillaries and even large-sized bile ducts running in the gallbladder bed (Figs. [illegible]). A removal of the gallbladder with the cold scalpel necessarily opens these bile passages and bile leakage results.

Bile whether sterile or not, has proved to act as [illegible] true chemical poison in the peritoneal cavity. Bakes[1] observed bile leaking from the wound [illegible] times in [illegible] cases of simple cholecystectomy. He and many other surgeons were [illegible]

[1] Bakes, J. J. [illegible] [illegible]

pressed by the postoperative appearance of bile in the dressing "in nearly all the cases."

3. After classical cholecystectomy the gallbladder bed cannot always be obliterated by sutures; the resulting raw rather large open surface is often responsible for bile leakage.

Fig. [illegible] Bile duct in gall bladder

From section shown in preceding illustration.

Experimental studies for [illegible] number of years have convinced the author[1] that if one could substitute [illegible] dry non leaking surface instead of [illegible] discharging cavity in the gallbladder bed sequence following cholecystectomy it would be [illegible] great step in the right direction. This thought has been brought to fruition by electrocoagulation. It has been shown that electrosurgical coagulation, properly performed, converts the tissues into [illegible] hyaline-like, dry necrotic, inert tampon (Fig. [illegible]). It is important to understand the differences between fulguration, [illegible]

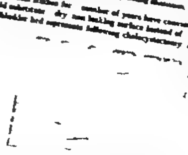


Fig. [illegible] Electrocoagulated gall bladder consisting of [illegible] hyaline network of inert tissue.

[1] Thorek, M. [illegible] [illegible] [illegible]

—— [illegible] Surgical Errors and Safeguards, Philadelphia and London.

—— [illegible] [illegible]

—— [illegible] [illegible]

—— [illegible] [illegible]

—— [illegible] Lancet, London, [illegible]

[illegible] and [illegible] terms often used promiscuously and not well understood.

Monopolar sparking from high frequency transformer (of Tesla, D'Arsonval, Oudin) was termed [illegible] by Keating-Hart and electrodesiccation by Clark, and later fulguration by Pozzi. [illegible] introduced the now accepted term diathermy. Bipolar diathermy for surgical purposes was first called [illegible] bipolaire and later electrocoagulation by Doyen. [illegible] and [illegible] spoke of endothermy showing that the heat is produced in the patient's body. George Wyeth, in [illegible], simplified the terminology by coining the terms medical and surgical diathermy. Heuchen speaks of cauterization, charring, Hautz-Rover of [illegible]. [illegible], Cooking of dehydration, [illegible] of electrotomy, von [illegible] of "[illegible]" etc.

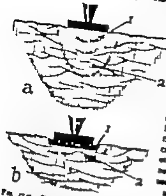


FIG. 1796. Diagram of effects of electrocoagulation and of carbonization. [illegible]

If the electrode of bipolar current is firmly applied to a tissue surface and a current of proper voltage and sufficient amperage is permitted to pass through it, dehydration and coagulation of the tissue-proteins result in a few seconds. This is manifested by the white color assumed by the tissue thus treated. This is called electrocoagulation. On the other hand, if the same electrode is not applied firmly or if used as unipolar or even bipolar instrument, a small air space (dielectricum) intervenes between the electrode and tissue, and sparking, fulguration, and carbonization with black discoloration of the tissues result. A coagulation of the electrode to such fulgurated or carbonized surface will stop further current penetration and prevent coagulation from taking place (Fig. 1797). Also, in cauterization, the heat is brought to the tissue from the outside by the heated instrument, while in bipolar electrocoagulation the heat is produced in the tissue body [illegible] oscillations per second depending upon the type of apparatus used (short-wave). When the liver is subjected to the electrocoagulating bipolar current definite tissue changes take place (Fig. 1798).

Electrocoagulated surfaces within the abdomen do not slough. Electrocoagulated tissues on the surface are thrown off, or extruded, while within the abdomen they become encapsulated and are absorbed. Furthermore, electrocoagulated surfaces on parenchymatous organs develop an affinity (positive chemotaxis) for serous surfaces, attracting contiguous organs covered with serosa

(bowels, stomach, etc.) I have observed agglutination three hours after electrocoagulating the surface of the liver. Firm union takes place in a comparatively short time (Fig. 1797).

The capillaries and blood vessels of an electrocoagulated area do not thrombose but [illegible] occlusion of the column of blood occurs within the vessel, above and below the point of contact of the electrode, and the vessel walls coalesce with the

FIG. 1798. Effects of electrocoagulation on liver tissue. [illegible]

contiguous homogeneous, hyaline-like structures [illegible] (Figs. 1798-1799). Such changes do not take place with fulguration or carbonization. [illegible] as a result of diathermy does not take place by thrombosis but by collapse and fusion of the walls of the vessels (Ellis). Coagulation thrombosis is [illegible] contradistinction to true thrombus formation (Aschoff). In electrocoagulated tissues in the gallbladder bed secondary hemorrhage does not occur, because of the pressure exerted by the [illegible], coagulated mass against the contiguous tissue.

FIG. 1797. Electrocoagulation of surface of liver with [illegible]

FIG. 1798. Mesentery of [illegible]. Electrocoagulation [illegible] (Ellis.)

FIG. 1799. [illegible] (Ellis.)

FIG. 1800. [illegible]

[illegible]

The operation described below is based upon the following factors:

The posterior gallbladder wall and bed of the gallbladder may be effectually electrocoagulated and their structure converted into an inert, dehydrated, hyaline-like aseptic tissue.

[illegible]

Electrocoagulated borders of the gallbladder may be approximated with sutures.

3. The ligamentum falciforme hepatis may be completely detached and when superimposed over an electrocoagulated surface it becomes intimately united with [illegible] (Fig. [illegible])

4. The abdomen may be closed without drainage provided the cystic duct is securely ligated and the cystic artery closed by double ligation.

Historical Notes. In 1926 [illegible] described electrosurgical cholecystectomy [illegible] [illegible] removed gallbladders by dissecting the gall bladder from its bed [illegible] with the diathermy knife instead of the scalpel [illegible] Drainage was used. It is obvious that the methods above described [illegible] to be in no way different from classical cholecystectomy except in substituting the cutting electric

current instead of the scalpel, therefore, having the gallbladder [illegible]

Fig. [illegible] Fig. [illegible]

[illegible]

[illegible]

depths of the affected zone in the gallbladder wall, viz., the [illegible] (Figs. [illegible])

The futility of simple fulguration of the mucosa of the gallbladder in advanced cases [illegible] Pribram [illegible] The deeper layers of the gallbladder were little or not affected at all (Figs. [illegible]) It appeared that the entire gallbladder should be destroyed to obtain better results. Later Alberts [illegible] In 1936, [illegible] years after [illegible] Heymann and Pribram reported their methods of electrosurgical cholecystectomy and [illegible] L. S. Whitaker[illegible] also used the cutting current in removing the gallbladder. Later, he

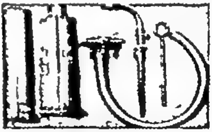


Fig. [illegible] Component parts of author's two-way gallbladder aspirator.

disregarded the [illegible] of Pribram and drained his patients [illegible] with the result that he lost [illegible] of [illegible] patients, [illegible] mortality of [illegible] per cent.

AUTHOR'S OPERATION

Thorough preoperative preparation of the patient is imperative.

Step 1. Wherever possible [illegible] block is the anesthetic of choice; otherwise [illegible] anesthesia [illegible] The patient is placed in the Mayo-Robson position (Fig. [illegible]) with the lower thorax and upper abdomen sufficiently elevated. Where the bipolar current is used [illegible] large, flat, [illegible] electrode is [illegible] applied over the sacrum. Where short wave is used [illegible] electrode is needed. Preferably [illegible] incision is made beginning at the lower costal margin and extending to about the level of the umbilicus. Exposure must be thorough (Fig. [illegible])

Step 2. Mobilization of the falciform ligament. This structure is completely detached from its attachments to the anterior abdominal wall, and is placed into [illegible] of warm salt solution. In detaching the falciform ligament from the anterior abdominal wall, some small vessels are severed. These must be carefully ligated. Pack the viscera out of the way and obtain good exposure by efficient retraction. Where the falciform ligament is too small [illegible] of omentum should be used as a free graft.

[illegible]

Step 3. The biliary passages are explored and the gallbladder is aspirated, using an especially designed aspirator (Figs. 776–777) which permits evacuation of the gallbladder contents into a receptacle via a rubber tube. After

FIG. 777. Author's [illegible] gall bladder aspirating [illegible].

emptying its contents, the gallbladder is filled with [illegible] (Fig. 777) or other antiseptic solution. Only about 3 per cent of bile contains microorganisms while their presence in the gallbladder walls may be demonstrated in over 50 per cent of cases. For that reason I introduce an antiseptic into the gallbladder before opening it.

FIG. 778. Aspiration of the gall bladder. [illegible] duct and artery have been doubly ligated. The ligatures are not shown.

The extrahepatic biliary passages are explored next. The cystic artery and duct are ligated doubly and [illegible] cutting both ligatures short (Figs. 778–779–780). Experience has taught me not to attempt extensive dissection in searching for the cystic artery if it is not easily isolated but to ligate it with the ligature to the cystic duct. This procedure should be followed, particularly in inflammation about the hepatoduodenal ligament. The frequent, abnormal course of the artery should be kept in mind.

Step 4. Open the gallbladder and evacuate its contents. A non-spilling gallbladder content receptacle (Fig. 779) collects the evacuated material without spilling it. Old fashioned gallbladder spoons are too shallow and offer

no protection against contamination from spilled contents. My instrument consists of a cone shaped container measuring 1½ inches in diameter and [illegible] inches in depth, mounted on a shaft of suitable size. A close-fitting cover

FIG. 779a. Gall bladder [illegible] [illegible]

is hinged and held open when in use by means of spring friction clips. Light pressure upon the cover releases it so that the material cannot spill during its removal. The front part of the receptacle is somewhat concave allowing sufficient latitude for proper contact with the cholecystic wall, and its edges are rounded, thus [illegible] injury to the liver.

FIG. 780. [illegible]

Step 5. Split the gallbladder longitudinally from above downward with an ordinary pair of scissors. Grasp half of the gallbladder wall with an insulated [illegible] forceps or an ordinary artery forceps sheathed in rubber tubing. In closing the forceps, the gallbladder wall is crushed and the blood vessels coursing in it are occluded by compression in a narrow ribbon (Fig. 781). With a pair of ordinary scissors remove the redundant portion of the gallbladder wall. Apply an electrode (see insert in Fig. 781a) along the exposed margin of the gallbladder which is held in the forceps. The current will electrocoagulate it but will not pass beyond the insulated part of the [illegible]. Release the forceps [illegible] compressed coagulated ribbon of tissue [illegible]

(Fig. 781b–c). Repeat the procedure the same way all around. Electrocoagulate the remaining portion of the posterior wall of the attached gallbladder which has not as yet been acted upon. I use a short-wave apparatus.

In my early cases I thought it advisable to electrocoagulate slowly but experience has taught me that quick, decisive coagulation has yielded the best results. The reasons for this are:

A low voltage and high amperage current is used on a rather moderate-sized electrode. On this unit (Fischer) as the voltage drops, the amperage increases. This affords prompt, thorough dehydration and a sharply defined line of demarcation between the coagulated and uncoagulated tissue. Tissue thus coagulated will retain less moisture than tissue coagulated more slowly. Less heat is imparted to the contiguous tissues. Another reason for advocating rapid coagula-

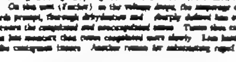


FIG. 781. Author's non-spilling bile receptacle.

tion with a smaller electrode is that slow coagulation results in heating of the tissues to quite an extent beyond the electrode, about 3 cm. in each case. There is no sharp line of demarcation in slow coagulation: the tissue changes are gradual.

When the diathermy electrode is used, it should be applied snugly to avoid carbonization. The current should be turned on only after the electrode is firmly applied and should be shut off before the electrode is removed from the coagulated surface. Avoid fulguration and its attendant carbonization. It will defeat the purpose of the operation. Any bleeding from the branches of the cystic artery is controlled by grasping the vessel and touching the artery forceps holding it with the electrode. Hemostasis will promptly result (Ward's procedure).

There is now an area represented by the electrocoagulated posterior wall of the gallbladder attached to the gallbladder bed.

Step 6. Approximate the electrocoagulated edges of the gall bladder by a few interrupted sutures (Fig. 781d).

Step 7. Some peroxide of hydrogen on a sponge is applied to the gall bladder bed area. The falciform ligament is now removed from the receptacle of warm salt solution. One end of the detached falciform ligament is sutured to the upper end of the sutured, coagulated gallbladder bed. The lower third of the ligament is now sutured to the lowermost end of the approximated, electrocoagulated surface and the free end of the ligament is placed, but not sutured against the doubly ligated end of the cystic duct and artery. An effective serous covering is thus formed over the gallbladder bed and cystic duct (Figs. 784, 784a).

Step 8. The laparotomy packs and retractors are now removed; the field of

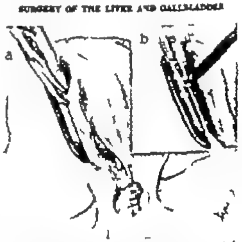


FIG. 781a. Opened gall bladder [illegible]

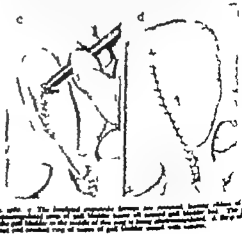
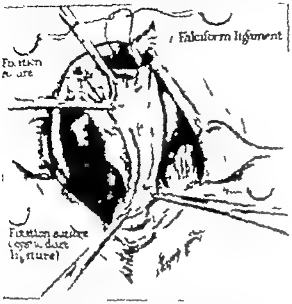


FIG. 781b, c. The [illegible]

operation is done, the ... operative field is ... and the abdominal wall is closed ... without drainage.

What becomes of the structures in the ... after the operation described? The answer ... has been given based upon ... experimentation. ...

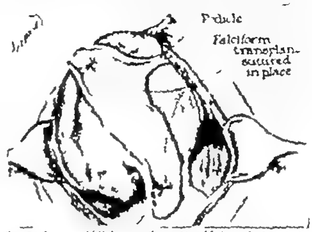


[illegible]

[illegible]

... cholecystectomy after the operation are frequently due to bile leakage, ... result of an inability to obliterate and cover the gallbladder bed which contains bile capillaries and often larger bile ducts, in ... per cent of the cases (Figs. ...). ... bile seepage. The method described seals these openings by electrocoagulation. A sterile, ... dry protective layer is substituted for ... raw ... surface. The falciform ligament is superimposed over this area. Drainage is entirely omitted.

This operation must not be confused with ... practiced with



[illegible]

[illegible]

[illegible]

[illegible]

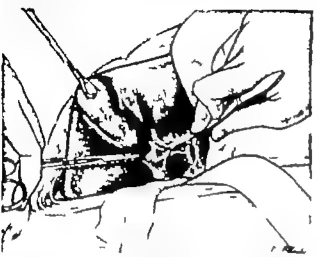
[illegible]

[illegible]

[illegible]

Step 4. Place a pair of curved artery forceps on the cystic duct about ¼ inch away from the second ligature and close to the neck of the gallbladder. Lift the duct cautiously upward and divide it with a knife, scissors, diathermy needle or cautery.

Step 5. Make a careful search for the cystic artery and occasionally for the right hepatic artery or the main trunk. Remember the possibility of anomalous cystic arteries or the possibility of the presence of more than one artery. Mangot dissects the cystic artery out with meticulous care and traces it to



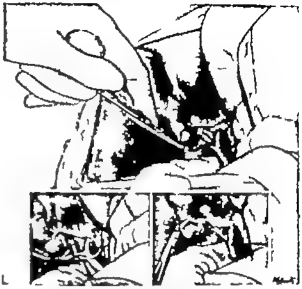
F[illegible] 77[illegible]. Cholecystectomy and choledochostomy. The cystic duct, the hepatic duct and the common bile duct are being [illegible] [illegible] the peritoneal [illegible] of the [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] the strip of gauze which has been placed in the foramen of Winslow. (Courtesy of Mr. Rodney Maingot.)

point where it is clearly seen to enter the gallbladder. When the artery is thus isolated, it is under-run by an aneurysm needle (Fig. 77[illegible]) threaded with silk and ligated as close as possible to the gallbladder. Maingot believes that many so-called "liver deaths" or unexplained fatalities following cholecystectomies are due to ligature of the main hepatic artery or its large right branch which are mistaken for the cystic artery.

Step 6. Divide the loose peritoneal reflection on either side of the gallbladder with a knife or diathermy blade (Fig. 77[illegible]). Occasionally Maingot resorts to Wilkie's method of infiltrating the loose peritoneum around the gallbladder with [illegible] saline or novocaine solution. This produces a diaphanous sodden wheal which renders the separation of the gallbladder a simple and

bloodless procedure and greatly facilitates the suturing of the margins of the liver bed.

Step 7. When about two-thirds of the gallbladder has been detached from its bed, the resulting raw surface on the gallbladder bed is obliterated by means of closely inserted interrupted catgut sutures of thick plain catgut while the gallbladder itself is used as a tractor to keep the liver in position well up in the wound (Fig. 77[illegible]).



772. Cholecystectomy and choledochostomy. The [illegible] [illegible] the method of tying the cystic duct and [illegible] of the cystic artery. The cystic duct [illegible] [illegible] and divided before the artery [illegible] [illegible] first. [illegible] [illegible] the artery [illegible] [illegible] [illegible] [illegible], the duct may be ligatured and divided first. (Courtesy of Mr. Rodney Maingot.)

Step 8. Isolate the common bile duct. Pack the area around it off with Mikulicz squares. Introduce two stay-sutures opposite one another through the anterior surface of the common bile duct about ¼ inch or more apart and about 1/3 inch below the insertion of the cystic duct.

Step 9. Lift these sutures upward exposing the common duct. Make a small nick with a small sharp-pointed knife between the sutures and between the taut anterior wall of the bile duct. As soon as the bile duct is open, bile will appear which is immediately aspirated by means of a metal suction tube.

Step 10. Enlarge the opening in the duct gradually until it is about ½ inch in length.

Step [illegible]. Palpate the ducts systematically once more and express their contents toward the opening just created. Stones which will be felt may be "milked" toward the incision in the duct and thence removed with forceps. If there be much biliary-sand irrigate the duct with warm salt solution, pass through a small rubber catheter attached to a Record syringe. Ascertain whether the

[illegible] 77[illegible]. Cholecystectomy and choledochostomy. The method of tying the cystic artery at [illegible] [illegible]. (Courtesy of Mr. Rodney Maingot.)

papilla is patent by passing graduated Lucas sounds or elastic bougies and, if so, gently dilate the lower end at the papilla. Make sure that the lower end of the sound is in the duodenum by palpating through the anterior wall of the duodenum while the sound is being rotated.

Step 12. Explore the common hepatic-duct and its main branches by means of the Desjardins forceps. Pass it upward to search for stones which may have escaped detection. Pass then the forceps downward into the duodenum, gently withdrawing it with its blades slightly open. This lessens further dilatation.

Step 13. Pass a small rubber catheter through the papilla into the duodenum and inject through it some saline solution. If the solution comes back to the wound it is evident that the point of the catheter has not negotiated the terminal portion of the duct. In such event, further attempts should be made until the saline solution flows freely into the duodenum. Where a stone is

firmly impacted in the ampulla and cannot be dislodged upward so that it may be extracted through the incision in the common-duct, or forced downward into the duodenum, mobilize the duodenum, make an incision on its anterior wall opposite the point of impaction. Introduce a metal sound into the duct and force the impacted stone upward so that it lies almost on a level with the incision in the duodenum. Make now an incision over the

[illegible] 77[illegible]. Cholecystectomy and choledochostomy. The gall bladder [illegible] being freed from its bed. (Courtesy of Mr. Rodney Maingot.)

stone through the posterior wall of the duodenum and extract the stone. Repair the wound in the posterior wall of the duodenum by the method described by Kellogg and Maingot. Pass a rubber catheter through the incision of the common duct downward until the point of the catheter emerges in the duodenum. Its point must project against the posterior wall of the duodenum. Close the incision in the anterior wall of the duodenum with three layers of sutures.

Step 14. Insert another rubber catheter through the incision in the common duct upward into the right hepatic duct.

Step 15. Close the opening in the common duct around the two catheters.

Step 16. Complete the cholecystectomy.

Comment. The ends of the catheter are made to emerge at the top and bottom of the abdominal wound when it is closed. Connect the ends of the

catheters by means of a glass tube so that the bile can flow from one tube into another without difficulty. The catheter in the hepatic duct may be allowed to drain into a bottle on the side of the patient while the tube in the duodenum may be utilized for feeding purposes (saline and glucose solution). When bile is seen after some time to have clear, the tubes may be removed. In the average case a T-tube is inserted and closed around the

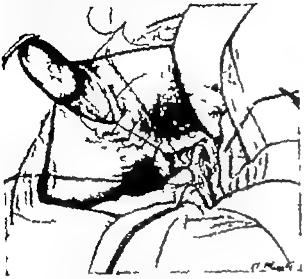


Fig. 775. Choledochotomy and choledocholithotomy. The gall bladder ... the bile ... partly ... and the T-tube has been inserted into the common duct. (Courtesy of Mr. Robert Maingot.)

duct with interrupted sutures, thus preventing leakage. The long limb of the tube must be securely anchored to the abdominal wall and led to a sterile container bottle which is fixed to the patient's dressings or the side of the bed. Never remove the tube when there is fever, muddy bile or clay-colored stools. Four ounces of bile are introduced into the rectum daily. The tube should be removed when the bile is clear.

CHOLECYSTANASTOMOSIS

Cholecystogastrostomy. Cholecystoduodenostomy

This operation is useful in establishing a communication between the gallbladder and the stomach or the gallbladder and the duodenum or jejunum. Usually the duodenum is selected for the anastomosis (Fig. 776)

The operation was conceived independently by Harley Gaston and Nussbaum. Winiwarter of Liège (1880–1881) first performed it. Mayo-Robson performed it first in England.

Indications

Chronic jaundice (obstruction of the common bile duct)

1. Tumors of the head of the pancreas.

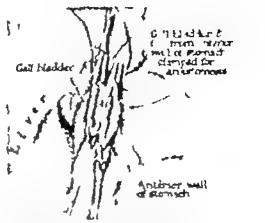


Fig. 776. Cholecystogastrostomy. Anastomosis of the gallbladder to the stomach ... [illegible]

3. Injuries to the common duct when ligation of the duct becomes necessary.
4. Tumors of the common bile duct.
5. Stricture of the common duct.
6. Certain forms of biliary fistulas.

Contra-indications

Small and atrophied gallbladder.
Calcified gallbladder.

The technic of the operation is essentially that of a lateral anastomosis (which see p. [illegible])

Step 1. Expose the gallbladder as described above.
Step 2. Aspirate the gallbladder. Grasp it with a gallbladder [illegible] forceps of Mayo-Robson type. A curved Doyen intestinal clamp may be used.

Step 3. Approximate the gallbladder to the stomach (cholecystogastrostomy) or to the duodenum (cholecystoduodenostomy). If difficulty is experienced in bringing up the duodenum, it is mobilized by Kocher's method (see p. [illegible], Fig. [illegible]). Occasionally it becomes necessary to detach the fundus of the gallbladder ... from its liver bed, to obtain ease of approximation.

Step 4. The two viscera, held in clamps, are now placed side by side and the surrounding territory is packed off with warm lap sponges. The first (outer) suture line of fine Pagenstecher linen unites the serous surfaces of the gallbladder and duodenum or stomach. The needle is kept ...

Openings are now made into the viscera to be united. These are about ½ of an inch in length and ¼ inch shorter than the suture line.

The second (inner) through-and-through suture of fine chromic catgut unites all the layers of the posterior surface of duodenum or stomach and gallbladder and continues similarly on the anterior wall as in gastro-enterostomy (which see p. [illegible]). After the inner suture is tied and cut the outer suture which is left long is picked up and is continued as a ... suture along the anterior surfaces until it reaches its starting point, where it is knotted and cut short.

Step 5. Remove the clamps and lap sponges. Cleanse the viscera with warm salt solution. The suture line may be reinforced by a free tags of omentum or ... with the ... ligament. Drainage is unnecessary.

Step 6. Close the abdomen in the usual manner.

Comment. While the duodenum is usually chosen to make the anastomosis, it is often difficult to bring it satisfactorily in contact with the gallbladder without undue tension. Anastomosis to the stomach is preferable because it is easily approximated to the gallbladder, as well as more mobile than that of the duodenum which occasionally contributes to the formation of duodenal fistula, a complication which is rather difficult to cope with. The entrance of bile directly into the stomach is of no moment. The anastomosis of the gallbladder with the jejunum is beset with many technical difficulties and may give rise to unpleasant complications. All in all, cholecystogastrostomy seems to be, for the reasons given, the procedure of choice.

Commenting on the advantages of cholecystogastrostomy, Albert Jostes points out that:

(a) Cholecystogastrostomy is an operation of great value when carried out with meticulous care and on proper indications. The gallbladder must be free from inflammatory changes, the cystic and hepatic ducts must be patent and the pylorus open.

(b) Cholecystogastrostomy is an operation for diverting the course of bile and not one intended for drainage. It is not capable of producing changes in the gastric mechanism to bring about cure for gastric ulcer.

(c) Mechanical obstruction of the ductus choledochus constitutes a definite indication for cholecystogastrostomy. Ascending pancreatitis, inflammatory changes in the biliary passages are to be treated by cholecystectomy, choledochostomy etc.

(d) An exact diagnosis is of paramount importance. Ascertain the exact indications for surgical therapy (Ewald's Wolfsgruber, etc.).

(e) Where the mechanism of a given case of jaundice is obscure, it is unwise to do a cholecystogastrostomy.

(f) The technic of the operation is simple.

(g) The results following the procedure are satisfactory particularly when the affection is not of neoplastic nature.

OPERATIONS ON THE BILIARY PASSAGES

Anatomic Considerations (see p. [illegible])

In the absence of complications there is usually no difficulty in identifying the common duct lying along the free edge of the hepatoduodenal ligament. Split the peritoneum, parallel to the duct. Strip the loose connective tissue away from the surface of the duct.

Do not overlook stones in the hepatic duct. When observed here, they may be washed out by irrigating the bile ducts. Irrigations must be gentle and never too forceful. Remember that destruction or removal of the gallbladder often overcomes the activity of the sphincter of Oddi affording free passage of calculi into the duodenum. (Fig. 777)

CHOLANGIOGRAPHIC DEMONSTRATION OF BILIARY DYSSYNERGIA

Best and Hicken[1] point out that: Cholecystograms, as sponsored by Graham and Cole, furnish valuable evidence regarding the gallbladder but they are of little value in disturbances of the common bile duct. Spasm of the lower end of the common duct (biliary dyssynergia) and other obstructive lesions of the extrahepatic bile ducts may be diagnosed by injecting opaque substances into the biliary tract. The biliary tract may be visualized by injecting radiopaque fluids into the common duct during operation. The injection of radiopaque substances postoperatively through catheters, tubes or fistulas, has been designated delayed cholangiography. A satisfactory contrast medium outstanding in the respect such as lipiodol, thorium dioxide sol and hippuran are used suitably; however each of these has its advantages and disadvantages. These substances must be absolutely sterile and must be warmed to 90° F. at the time of injection. Lipiodol (Cibo) is being infused all which apparently meets ... reaching, therapeutic common duct. Best and Hicken used it in the

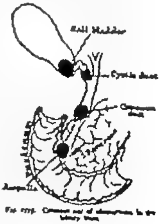


Fig. 777. Common site of obstruction in the biliary tract.

[1] JAMA, [illegible]

plicated by high temperature. Lipiodol is very viscid and some difficulty may be encountered in injecting it into the biliary tract through a small bore needle as is necessary in making an immediate cholangiogram. If a large calibre needle is used, the oil seeps out from the puncture wound and infiltrates the subperitoneal tissues, giving a hazy indefinite cholangiogram. Smaller stones in the common duct may be obscured.

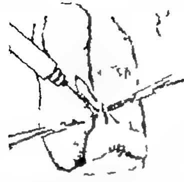


Fig. [illegible]. The common bile duct [illegible] exposed [illegible] [illegible] [illegible] ligated with attached to [illegible] syringe is used to identify the common duct [illegible] ligated. [illegible] small hand may placed [illegible] the [illegible] procedure. [illegible] biliary [illegible] [illegible] the duct [illegible] forceps. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] cholangiogram [illegible] [illegible] during the removal of the gall bladder. A [illegible] satisfactory method [illegible] [illegible] [illegible] [illegible] the gall bladder or the stump of the cystic duct. (Courtesy of Drs. [illegible] and [illegible].)

Thorium dioxide sol gives an excellent pattern of the bile ducts. Some assert that it has carcinogenic properties. This has not been substantiated.

Hippuran is a [illegible] per cent aqueous solution of organic iodide and has proved to be a very satisfactory cholangiographic medium.

Mirizzi showed in 1932 that the common bile duct could be visualized at the operating table by injecting it with radiopaque substances.

CYSTICOTOMY

This operation consists of opening the cystic duct followed by immediate repair. The operation is only of historical interest and was often used by surgeons some decades ago for the removal of stones in the cystic duct or for the relief of hydrops of the gallbladder occasioned by the obstruction of the cystic duct by biliary calculi. The procedure was first performed by Lindner in 1892. In some cases, however, it may be used.

Step 1. Expose the cystic duct. Incise it.

Step 2. Remove the stone or stones.

Step 3. Close the wound in the duct by two rows of catgut sutures. Do a chemical cholecystectomy.

HEPATICOTOMY

This procedure is analogous to the preceding except that it is the hepatic duct which is attacked surgically. It was first performed by Kocher in 1889—not premeditatedly but accidentally, for Kocher thought he opened the gallbladder when as a matter of fact he got into a much dilated hepatic duct. The inaccessibility of the hepatic duct makes this operation a difficult one. Whenever possible, it is best to attempt to "milk" the stone into the common duct or into the gallbladder whence it is removed.

EXPLORATION AND DRAINAGE OF THE BILE DUCTS

Supraduodenal Choledochotomy and Choledocholithotomy

[illegible] [illegible] Operation

Step 1. Make an ample incision. Thorough exposure. Explore the bile passages thoroughly. If the gallbladder is distended aspirate its contents. In common duct stone, the gallbladder is usually shrunken. (Fig. [illegible].)

Fig. [illegible]. Choledochotomy and choledocholithotomy.

Step 2. Endeavor to deliver the liver as described above and displace it to the right. Place lap packs as indicated. Locate the stone. Endeavor to "milk it" upward into the gallbladder. If unsuccessful, introduce two fine plain catgut stay sutures longitudinally into the duct on either side of the stone. These steady the duct during the operative manipulations and later can be used to close the opening made in the duct.

Use the sutures as tractors. Make sure you are dealing with the duct. If in doubt introduce a delicate needle into the structure; aspirate; if it is vessel, blood will issue (Derver) (Fig. [illegible]).

Grasp the stone between two fingers, incise longitudinally over the stone and extract it with forceps. Explore the duct with finger or scoop. Make sure that the exploring instrument has entered the duodenum proving the patency of the passage. Pass the instrument into the hepatic duct (Fig. [illegible]). Clear the passages of concretions. Remove bile accumulating during

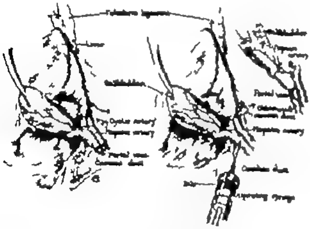
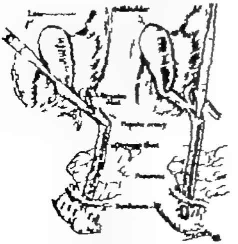


Fig. [illegible]. Exploration of the common bile duct, portal vein and hepatic artery [illegible] [illegible] method of visualizing the common bile duct. (Walters, Surg. Gynec. Obst.)



[illegible] of the common bile duct, especially the intramural [illegible]. (Walters, Surg. Gynec. Obst.)

the operation with a suction apparatus. Exploration of the biliary passages routinely in every gallstone operation is advocated by some, to be omitted only because of technical difficulties or absolute assurance from external examination that no concretions exist. It should not be omitted in the presence of jaundice. Alternate introduction and withdrawal of the finger from the duct, as advocated by Mayo, may produce sufficient suction to bring out

Fig. [illegible]. Drainage of the hepatic duct by Mayo-Robson [illegible] [illegible]. (Walters, Surg. Gynec. Obst.)

stone particles. Wicks of gauze of proper size introduced into the ducts and briskly removed will often dislodge and bring to the surface small particles of concrements.

Moynihan's maneuver procedure often proves useful in the removal of an impacted stone where dense adhesions exist. It is indicated when the gallbladder is shrunken and when the separation of dense adhesions would jeopardize the patient. The procedure consists in passing the left hand segmentally beneath in front of the pylorus and above the stomach along the gastrohepatic omentum and rotating the common duct up into the wound.

Step 3. Treatment of the wound in the duct.

Method I

(a) Perform cholecystostomy

(b) Close the opening in the duct with interrupted catgut sutures

(c) Introduce cigarette drain down to but not on the sutured wound in the duct.

(d) Close the abdominal wall as described above

Method II

In view of the fact that drainage of the biliary tree is necessary by reason of the existing cholangitis and pancreatitis, this method is most commonly used

(a) A soft rubber catheter (No. [illegible] to [illegible] French) with its end cut off and an aperture made about one-half inch from its extremity is passed through the opening made in the duct and directed upward toward the hepatic duct (hepaticus drainage, Mayo-Robson) (Fig [illegible]) for about an inch or so. The catheter is fixed in place by catgut suture. The rest of the opening in the duct is closed by interrupted catgut sutures. The stay sutures, previously placed, may be used instead of the interrupted sutures, by bringing the former together and tying them securely. A tab of omentum may be used around the catheter for further protection. Introduce rubber or cigarette drain into Morison's pouch. Close the abdomen. The catheter is permitted to remain week or two longer, if deemed advisable. The cigarette drain is removed about the third day.

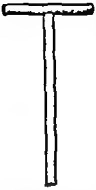


Fig. [illegible] Kehr's tube.

(b) A T-tube of Kehr may be used instead of the method described (Fig [illegible]) and the closure of the wound of the duct effected as indicated in (a)

Comment. In operations on the biliary passages exposure must be ample. In affections of the common bile duct, it should be dealt with first before operative procedures are carried out on the gallbladder. Do not mistake enlarged and calcified lymph nodes in the gastrohepatic omentum for calculi. Avoid injury to the portal vein or the hepatic artery. Thorough exposure and careful operating are essential. If in doubt aspirate the structure in question as recommended by Deaver. Should the portal vein be punctured, the bleeding can readily be controlled by the application of pressure for few moments to the aperture made by the needle.

The course and direction of the common duct should be noted by thorough exploration (Fig [illegible]). In splitting the peritoneal covering of the common duct, avoid injury to the venous plexus of Zuckerkandl. These vessels should be pushed aside or divided between ligatures.

Fatalities resulting from accidental ligation of the hepatic artery have been reported. Roscoe R. Graham of Toronto recently reported reviews of the literature and [illegible] previously reported cases. His conclusion

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Ligation of the hepatic artery is always serious, but not necessarily fatal, accident.

The prospect of liver necrosis increases steadily as the point of ligature moves toward the periphery

The extent of necrosis and the absence of clinical and laboratory evidence of its existence in the case he reported is remarkable.

The rather delayed development of liver insufficiency in man contrasts sharply with the findings in experimental animals, and makes successful operative interference at the former possibility.

Kirschner advises opening the common duct through separate longitudinal incision in its anterior wall, few centimeters below the opening of the cystic duct "from which it is not always possible to probe in the direction of the liver". If the progress of the flexible probe is impeded during the exploration of the duct it should be bent to conform to the direction of the duct.

If gravel is contained in the ducts it should be washed out with salt solution introduced through soft rubber catheter on the nozzle of glass syringe. Avoid forcing probe which meets obstruction at the lower end of the duct because false passages may result which may eventuate in retroduodenal cellulitis and peritonitis.

Where stone is inextricably impacted in the less accessible parts of the ducts, try the injection of ether through rubber catheter passed to the stone in the common duct and there anchored. *Inject drachm of ether once or twice daily.* This method is recommended by O. B. Pribram who assured me that it succeeds in all cases. In my own cases it has not invariably proved successful. It is worth trying. Walters[1] succeeded with this ether method in dislodging an impacted stone aided by the use of amyl nitrite.

CYSTOCHOLEDOCHOSTOMY

Halsted Reid Operation

Step [illegible] Expose the cystic and common duct thoroughly

Step [illegible] Ligate the cystic artery. Clamp the cystic duct and divide it about cm. from its origin.

Step 3 Excise the gallbladder. Incise the common duct and remove all discoverable stones.

Step 4. Pass probe as large as possible into the duodenum. Stretch the stump of the cystic duct and, if need be, use for stretching clamp or other instrument (Fig [illegible])

Step 5. Introduce tube of selected size (catheter) through the cystic into the common duct, before suturing the incision in the latter (Fig [illegible]). The catheter is maintained in place by stitch of catgut No. 00, passed through on side into the wall of the cystic duct.

Step 6. Close the incision in the choledochus by one or preferably two rows of interrupted fine silk sutures (No. [illegible]) Reid used several times the finest catgut (interrupted sutures) for the inner row of sutures (Fig [illegible])

Step 7. Test the line of suture by injecting salt solution through the tube and protect the suture line from the drains by overfold fat or other tissues.

[1] Surg. Gynec., Obst., Nov [illegible]

Step 8. Place three or four very thin Halsted drains or slender cigarette drains about the rubber catheter. Make the cystic duct hug the catheter closely. Reid admonishes that the employment of the largest possible size of tube,

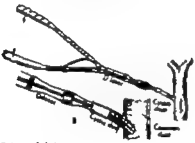


Fig. [illegible] Halsted's method of dilating the cystic duct. (Courtesy of Dr. Mont R. Reid.)

is the unfounded hope that perhaps stone may escape through it, is undesirable

Step 9. Close the abdominal wound in layers one stratum of silk reinforced by two or three through-and-through stitches of silkworm-gut.

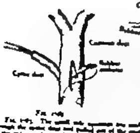


Fig. [illegible]

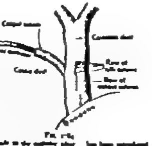


Fig. [illegible]

Fig. [illegible]. The small side opening has made in the catheter where it has been introduced through the cystic duct and pulled out of the opening in the common duct. [illegible] to the common duct and anchored to the cystic duct before the incision of the common duct closed. In this case not showing the final position of the end of the catheter. Fig. [illegible]. Cystocholedochostomy completed except for the second row of sutures in the common duct. (Courtesy of Dr. Mont R. Reid.)

Comment. The drains are removed, some on the second or third day the remainder on the fourth or fifth day. The catheter in the duct should not be disturbed until there is reason to believe that the wound in the common duct is firmly healed. In case of obliteration of the cystic duct, one

should make second opening in the choledochus just large enough to admit small tube and completely close the original incision (Fig [illegible]). The operation may occasionally be difficult or even impossible. In all of Reid's cases the tube has been pointed toward Vater diverticulum, and in none of them did it become kinked or obstructed. The curve of the tube is probably supported by the cystic duct and the under surface of the liver. When the cystic duct is too small to admit tube of the required size it should be dilated with either fine clamp or special instrument. The tube Reid usually employed is catheter size No. [illegible] of the French scale but [illegible] is sufficient. The tube should be snugly embraced by the cystic duct which, if too large, should be reduced in size by stitch or two. Occasionally one may have to split the duct for short distance to facilitate the introduction of the catheter.

Orr's Improved T Tube for the Drainage of the Common Bile Duct

Because of the difficulty in introducing the ordinary T-tube into the common bile duct, and because of the pain and trauma incident to its removal, *Thomas G. Orr*[1] devised modification which removes in large measure these two objectionable features (Fig [illegible])

Fig. [illegible]. Method of avoiding the placing of tube through the incision of the common duct when cystocholedochostomy cannot be done. (Courtesy of Dr. Mont R. Reid.)

By cutting notch in the tube, as shown in the illustration at 1, the two short arms of the T can be readily folded together as in 2, when being introduced into the common duct. The ordinary T-tube is not sufficiently flexible to fold readily when being withdrawn from the duct as shown at [illegible]. When notched, as in [illegible] the short arms of the T fold smoothly together and may be withdrawn through relatively small opening, as in 3

RETRODUODENAL CHOLEDOCHOTOMY

Kocher Operation

This operation is rarely performed. Mayo-Robson reminds us that in an experience of nearly one three of choledochotomy he has yet to meet with case in which he could not work the calculus backward to the first portion of the duct whence he could remove it, or reach it from below after laying the papilla open. He, therefore, cannot see the necessity of this modification of the operation of choledochotomy

Besides, it must be remembered that the inferior vena cava is in close [illegible] or the duct may be covered with pancreatic tissue. Again, [illegible] this portion of the duct is not covered by peritoneum, [illegible] may

Should it, however become necessary to resort to this [illegible] forward as follows.

Mobilize the duodenum by Kocher's method (Fig [illegible]

[1] Am. Surg., [illegible]

duodenum turned, then exposing the duct coursing behind, in its retroduodenal or upper pancreatic portion. Here it lies beneath the surface of the pancreas which must be incised. Locate the stone. Incise the duct over it and remove the stone. Close the opening made in the duct with a double layer of interrupted catgut sutures. Replace the duodenum and suture it in place. Drain with a rub-

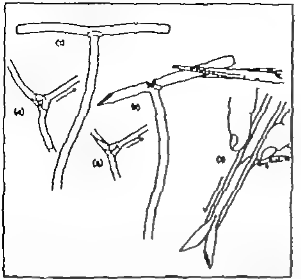


Fig. 1786. Ott's improved T-tube for draining the common bile duct. (c) Old-type tube. (a) T-tube notched and dissected. (b) Crossed ... [illegible] (d) ... [illegible] (e) ... [illegible]

ber tube bringing its distal end out of the hole at the outer side of the right kidney. Cholecystostomy may supplement this procedure, if deemed advisable.

TRANSDUODENAL CHOLEDOCHOTOMY

There are two varieties of this operation

(a) Transduodenal choledochotomy (Kocher's operation).

(b) Transduodenal (ampullary) choledochotomy (McBurney's operation).

Transduodenal Choledochotomy (Kocher's Operation)

This procedure is used in removing an impacted stone from the lower part of the common duct, but not in the ampulla of Vater. The technic is that of dividing the anterior and posterior wall of the second portion of the duodenum, the stone is palpated and the wall of the duct incised over the impacted calculus

(Fig. 1788 b). To facilitate the operation, particularly in obese individuals, mobilization of the duodenum and its delivery into the wound, together with the head of the pancreas, is, if thorough work is aimed at, essential. After the duodenum is opened its contents are aspirated, after first protecting the surrounding structures with lap sponges. An incision is made over the stone, the divided margins of the duct are caught in lateral sutures which are left long to act as retractors. The stone is removed, the duct is explored from above and below and its patency assured. Before an incision is made into the duct, every effort should be made to extract the stone through the ampulla. After closing the duct, the incision into it and into the posterior duodenal wall are closed with fine

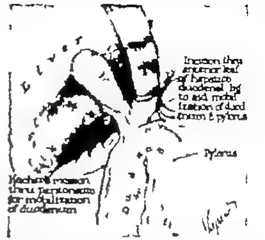


Fig. 1787. Kocher's incision for mobilization of duodenum. The duodenum and pylorus may be further mobilized by an incision shown on the right.

interrupted through-and-through catgut sutures. The incision in the anterior duodenal wall is closed transversely with two rows of chromic catgut sutures. A third row of interrupted (mattress) sutures of Pagenstecher linen ... while preferable. Over this, a flap of omentum or of falciform ligament is sutured. It protects the anterior duodenal wall from possible leakage. Secure closure is the safeguard. If soiling has taken place, or if complicated cholangitis exists, drainage should be resorted to. With meticulous technic without soiling, closure of the abdomen may be permissible. Nevertheless, I still am partial, under such conditions, to Moynihan's "insurance drain."

Transduodenal Ampullary Choledochotomy (McBurney's Operation)

This operation is resorted to if the stone is impacted in the ampulla of Vater and cannot be removed in any other way. The stone in the papilla is

exposed as in Kocher's operation, except that the incision in the posterior duodenal wall is made at a slightly lower level (Fig. 1788 a). The edge of the papilla is incised sufficiently to permit the stone to be extracted. Explore the duct and clear it of stones or gravel. The rest of the operation is conducted as outlined in the previous procedure. What has been said about drainage holds good here also. When drainage is used, the drains should never be carried down to the duodenum. Duodenal fistulae will result from ignoring this precaution.

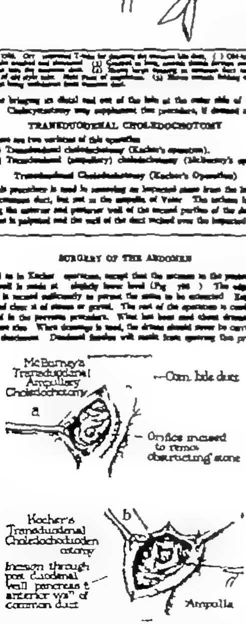


Fig. 1788. a, b. Transduodenal approach for removal of stone obstructing the common bile duct.

Difficulties Encountered During Choledochotomy Operations. The presence of a calculus in the common duct, particularly in its lower divisions is often difficult to foretell with any degree of certainty.

Inflammatory thickening of the duct or the tumor (pancreas) surrounding it may mask the presence of a stone. Diagnosis is often very difficult for no less an authority than Moynihan speaking on the question in his monumental work[1] admonishes that "We all have to pass through a time of difficulty. I feel much more confident about the matter," he says, "than I did ten years ago. I do not find the old difficulties disturbing me, as they used to so painfully. But that is only to confirm what I have so long believed that in no department of surgery is long practice so helpful, and, indeed, so necessary, as in that which deals with cholelithiasis."

[1] Abdominal Operations, W. B. Saunders Co., 1926.

OPERATIONS FOR IRREMOVABLE OBSTRUCTIONS OF THE COMMON DUCT

Choledocho-enterostomy

KEHR'S OPERATION

This is a short-circuiting procedure in cases of irremovable obstruction of the lower end of the common duct. It consists of joining the dilated duct with the duodenum or some other part of the intestine.

Step 1. Mobilize the duodenum as already described (Fig. 1787). Such mobilization must be thorough and enable the operator to bring the duodenum up and to be applied without tension to the side of the dilated supraduodenal portion of the common bile duct.

Occasionally if the common duct is enormously dilated it may be brought down to meet the duodenum to which it is to be joined.

Step 2. Apply a curved clamp forceps to the duodenum; and in marked dilatation of the duct a similar clamp is applied to it. The two clamped viscera are placed side by side in position for anastomosis.

Step 3. Make a transverse opening in the duodenum and in the dilated duct, about 3/4 of an inch in length. If the duct is narrow a longitudinal incision should be made into it. In view of the small size of the structures to be joined, very fine instruments should be used. Those used for blood vessel surgery are excellent for the purpose.

Step 4. Unite the opened viscera, with a two-row suture anastomosis, an outer serous suture of fine Pagenstecher linen and an inner through-and-through suture of fine, chromic catgut embracing the entire thickness of the walls to be joined. The anastomosis is performed on the same principle as detailed under cholecystenterostomy (which see, p. [illegible]).

Step 5. Close the abdomen without drainage.

If the obstruction is benign and the operation successfully executed, excellent results will follow.

If, for some reason (adhesions, etc.) the duodenum cannot be utilized for anastomosis, the jejunum is mobilized into service. The operation consists of bringing up a loop of jejunum about 20 inches from the [illegible], and anastomosing it to the dilated duct. In order to avoid kinking and consequent intestinal obstruction, this should be supplemented by a jejunojejunostomy.

CHOLEDOCHECTOMY

DOYEN'S OPERATION

This operation is resorted to in cases of tumors of the common duct or in strictures of the duct following surgical intervention.

The supplementary procedures at the surgeon's disposal after the tumor or stricture is resected are: (a) end-to-end union with or without drainage; (b) the distal end of the duct may be closed and the proximal end implanted into the intestine; (c) both ends of the duct may be closed and cholecystenterostomy performed.

RECONSTRUCTIVE OPERATIONS ON THE COMMON BILE DUCT

Damage to the common duct usually results from pressure of calculi or accidental injuries during surgical operations, followed by fistulae or strictures.

In stenosis or division of the common duct, several procedures are available

Resection of Scar with End-to-End Anastomosis

When during an operation it is discovered that the duct has been divided, direct end-to-end anastomosis of the duct is a comparatively simple matter. A prerequisite is careful union of the divided ends without tension. The story is different when union has to be made some time after the accidental division of the duct—the duct ends are then often found retracted and difficult to mobilize sufficiently to approximate them without tension.

If, after resection of a stricture the gap is not too wide, a direct end-to-end anastomosis may be done

Step 1. Identification of the structures is of paramount importance. This is often beset with many difficulties.

Step 2. Separate the structures involved carefully, painstakingly and with deliberation.

Step 3. Clear the foramen of Winslow.

Step 4. Liberate the duodenum from its attachments (Fig. [illegible], p. [illegible])

Step 5. Define the gastrohepatic omentum. Avoid the portal vein. Even after months of drainage the lower end of the duct does not shrink in diameter and is of quite normal size.

Step 6. Excise the stricture or freshen the ends of the divided duct.

Step 7. An end-to-end union of the ends of the divided duct demands meticulous technic and fine suture material (fine Japanese silk and fine straight or curved needles, [illegible] cm. long)

W. J. MAYO'S METHOD

Step 1. The structures are dissected out until the ends of the hepatic and common ducts lie free.

Step 2. Several chromic catgut stay sutures are introduced, catching the tissues behind the duct ends; these, when tied, obliterate the posterior space and bring the hepatic and common ducts into position for suturing (Fig. [illegible])

Step 3. A few catgut through-and-through sutures are placed so as to unite the duct ends posteriorly.

Step 4. The open end of the common duct is split along its anterior surface, one-third of an inch, as advised by C. H. Mayo. The splits in the free border of the common duct increases its caliber to a considerable extent. It then [illegible] readily adapted to the dilated hepatic duct.

Step 5. A T-tube of appropriate size is now introduced, one arm extending about one inch into the hepatic duct, to its primary division, and the other arm, if possible, through the entire length of the common duct until its free end passes into the duodenum (Fig. [illegible])

Step 6. *The gap about the T-tube is closed with chromic catgut sutures.*

Step 7. The tube is fastened to the hepatic and common ducts, respectively

[1] Surg. Gynec. & Obst., [illegible]

with an absorbable suture and the line of union protected by such omental and peritoneal tissues as are available. Moynihan prefers to use two tubes instead of a T-tube which is not so easily [illegible] withdrawn. He also lays stress on the mobilization of the duodenum and the use of supporting sutures to relieve tension on the suture line.

Step 8. A few rubber tissue drains properly arranged in the abdomen are supplemented, and the abdominal wall is closed.

Comment. The T-tube is permitted to remain in place from one to several months or until clamping of the projecting end is borne without distress.

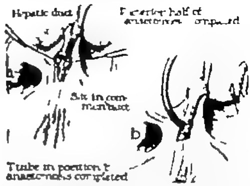


Fig. [illegible]. W. J. Mayo's method of end-to-end anastomosis of the hepatic and common ducts. The posterior half of the two ducts are joined first, then a short slit is made in the anterior wall of the common duct to help admit a T-tube. The tube in place, the slit and anterior walls of the ducts are sutured.

DIRECT HEPATICODUODENOSTOMY AND HEPATICOGASTROSTOMY

W. J. MAYO'S OPERATION

If the lower end of the common duct cannot be defined, the union of the upper end of the common hepatic or common bile duct to the mobilized duodenum comes under consideration. An implantation of the open end of these ducts into the duodenum reproduces normal conditions more nearly than any reconstructive operation except an end-to-end anastomosis of the common bile duct.

To this phase of biliary duct surgery W. J. Mayo again contributed much. His original article[1] reports two successful hepaticoduodenostomies.

The operation (Fig. [illegible]) consists of

Step 1. Mobilization of the duodenum and securing it to the contiguous tissues in order to retain it in contact with the severed ends of the hepatic duct.

Step 2. Opening the hepatic duct above its constricted portion.

[1] Ann. Surg., [illegible]

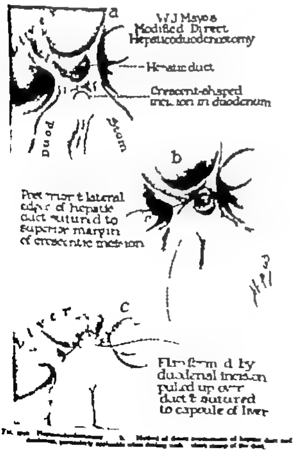


Fig. [illegible]. Hepaticoduodenostomy ([illegible]). Method of direct anastomosis of hepatic duct and duodenum, particularly applicable when dealing with a short stump of the duct.

Step 3. Ligation of the inferior portion of the common duct.

Step 4. Preparation of the superior portion of the duct.

Step 5. Make an elliptical incision in the duodenum about the diameter of the duct, embracing all its coats, at the point at which approximation with the duct is thought most easily accomplished (Fig. [illegible])

Step 6. Placing sutures from the mucocutaneous side through all the coats of the bile duct and duodenal wall to form the posterior half of the anastomosis (Fig. [illegible])

Step 7. Placing two rows of sutures alternately externally and internally in such a manner that the two rows complete the anterior half of the anastomosis, the inner row penetrating the full thickness of the wall of the duct and the duodenum while the outer line penetrates only the serous coat (Fig. [illegible])

Sullivan and McArthur suggested the introduction of a short rubber tube into the duct over which any form of anastomosis becomes considerably easier. C. H. Mayo states that these tubes make excellent scaffolding on which to reconstruct the duct. The tube may be permitted to remain in situ for long periods.

W. J. Mayo later modified his method of hepaticoduodenostomy. Donald C. Balfour[2] describes that modification as follows: "After freeing the structures from adhesions and then thorough isolation and mobilization, a slightly curved incision about [illegible] cm. in length is made in the duodenum embracing all its coats. The posterior margin of the opening thus produced and the posterior edge of the prepared stump of the hepatic duct are sutured in a mucocutaneous manner. The anterior margin of the duodenal incision is not sutured to the edge of the hepatic duct, but is brought up as a flap over the anterior aspect of the bile duct and is sutured to the under surface of the right lobe of the liver, the sutures passing into the capsule of the liver and into the thin tissue" (Fig. [illegible])

DIRECT HEPATICOJEJUNOSTOMY

In 1928 Monprofit reported to the French Surgical Congress his advocacy of direct hepaticojejunostomy or choledochojejunostomy by the Y method.

INDIRECT HEPATICODUODENOSTOMY

In cases where the condition of the patient prohibits extensive dissections, or when it is found that it is impossible to free the structures from adhesions and to successfully bring them together to be united, failure will surely result if direct junction is attempted.

Indirect junction of the biliary tract with the intestinal canal by scaffolding the breach with a rubber drainage tube to allow the formation of a new duct around and to replace the rubber tube should then be attempted.

Arthur G. Sullivan[3] has shown that:

Reconstruction and regeneration of a bile duct can take place about a rubber drainage tube which bridges a gap in a defective bile duct or between the superior end of a severed bile duct and the duodenum.

Reconstruction of the bile duct can be accomplished by utilizing neigh-

[1] Boston [illegible], July [illegible]
[2] Annals of Surgery, [illegible]
[3] J.A.M.A., [illegible]

boring structures and slightly traumatized mucosa which is placed about the rubber tube.

3. After a duct is formed from neighboring tissues and the mucosa, epithelization takes place on the inner surface of the newly formed duct walls by means of outgrowths of epithelium from the mucous membrane.

Jenckel's Indirect Hepaticoduodenostomy

Jenckel's operation was performed by him in 1905; he reported it in 1910. He preceded Bufferna's classic experiments. Figure 791 depicts the operation. Jenckel operated on a patient on whom a cholecystectomy had been performed eight months previously. He found that the common bile duct and the lower

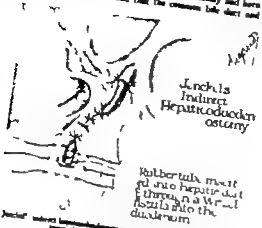


Fig. 791. Jenckel's indirect hepaticoduodenostomy. A rubber tube placed to communicate between the hepatic duct and the duodenum.

portion of the hepatic duct were obliterated; the stump of the hepatic duct and the duodenum were so bound down by adhesions that mobilization of the structures was impossible. He then performed his operation which consisted of inserting one end of a rubber tube the size of his little finger and slightly shorter than the hand, in the hepatic duct, the other end of the tube he inserted obliquely in an opening in the duodenum through a Witzel fistula. When Jenckel thought that epithelization had taken place along the reconstructed duct, he removed the tube at a subsequent operation. His patient reported well four years after the operation.

Walton's Plastic Hepaticoduodenostomy

A. J. Walton performed this operation in 1914 and described it in Surg. Gyn. and Obst., 1913. He reconstructed the common bile duct and made a new communication with the duodenum. The reconstruction was made necessary by the obliteration of the common bile duct.

A tongue-shaped flap was cut from the duodenum and, at first, reflected downward (Fig. 792). The defect in the duodenum was closed except for an aperture at the base of the flap, about the size of the bile duct. One end of a rubber drainage tube was placed in the opening in the duodenum and the other end in the stump of the bile duct. The flap was then reflected upward over the tube (Fig. 792 b, c, d). The tip of the flap was sutured to the anterior margin of the bile duct and the lateral margins of the flap were sutured to the serous surfaces of each other along the axis of the rubber tube. The canal, with its anterior and lateral aspects lined with mucous membrane and its posterior aspect lined with the serous surface of the duodenum, formed a new bile duct. Eleven days after the operation the tube was passed from the intestine. There had been no leakage of bile from the wound (study Fig. 792 and legend in conjunction with text).

CHOLEDOCHOPLASTY

MOYNIHAN'S OPERATION

The first plastic operation on a bile duct without the use of a graft was performed by Moynihan in 1904. He reported his case in the British Medical Journal in 1905. The case was one of stricture of the common duct, which was incised longitudinally through the stricture and for some distance above and below it. The edges of the incision were united transversely. A drainage tube was passed upward and another tube downward. Moynihan prefers this to a T-tube arguing that tubes may be removed with greater facility than can T-tubes, without traumatizing the sutured bile duct. The tubes were removed on the eleventh day. No bile flowed into the intestine until the fifth week. External drainage ceased in the ninth week. Four years after the operation the patient reported well.

OPERATIONS FOR EXTERNAL BILIARY FISTULAS

Discovery of the underlying etiologic factor and its removal are essential to success in this class of cases.

Closure of gallbladder fistulas are treated on the same basis as internal fistulas, viz.: (a) excision of the structures leading to the fistula; (b) excision of the gallbladder; (c) closure with one or two layers of sutures; (d) closure of the abdomen with or without drainage depending on existing conditions.

Whenever possible cholecystectomy should be performed making sure, of course, that the bile enters the intestine.

Numerous methods have been devised to implant a biliary fistula directly into the gastro-intestinal tract. Of these Czerny's operation, Von Haberer's direct implantation of a freely dissected biliary fistula into the pylorus, Maram procedure, and Routh's and Walton's operations are outstanding examples.

Operations for the Establishment of a Direct Communication Between the Parenchyma of the Liver and Alimentary Tract

These consist essentially of some form of hepatocholangio-enterostomy hepatocholangiogastrostomy, hepatocholangioduodenostomy or hepatocholangiojejunostomy. The latter was first suggested by Langenbuch in 1887 and consisted of effecting an anastomosis between the intestine and the smaller hepatic ducts.

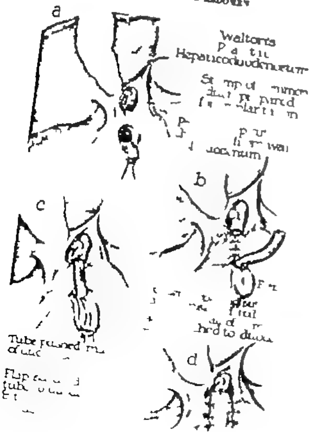


Fig. 792. [illegible]

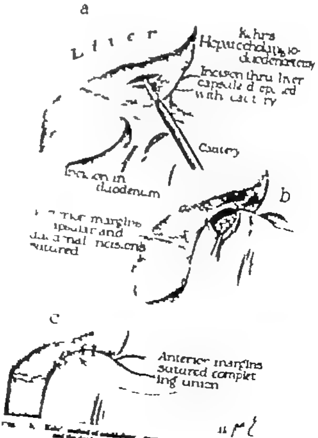


Fig. 793. Kehr's method of establishing communication between the liver parenchyma and the duodenum (hepatocholangioduodenostomy).

It finds its indication in cases where there is permanent obstruction of the common and main hepatic ducts or of the common and cystic ducts.

KEHR'S OPERATION

Step 1. Exposure of the gallbladder portion of the [illegible], [illegible], etc. as described above. If necessary remove the gallbladder.

Step 2. Excise, from a convenient portion of the lower margin of the right lobe of the liver, a strip of liver tissue about two and one half inches in length and about one inch wide. With the thermocautery burn a hole in the liver to such a depth that several moderate sized bile ducts are opened (Fig. [illegible]).

Step 3. Choose a segment of bowel, preferably the duodenum (hepatocholangioduodenostomy) or stomach (hepatocholangiogastrostomy). If the stomach is under tension use the jejunum (hepatocholangiojejunostomy) and proceed as follows: make an opening in the segment of bowel selected about two or two and a half inches in length and suture it to the margins of the wound in the liver.

CHAPTER 36

SURGERY OF THE PANCREAS

Anatomic Considerations. *The pancreas has no distinct capsule.* It is disposed transversely across the upper part of the posterior abdominal wall. It is divided into head, neck, body and tail (Figs. 794, 795).

The head occupies the concavity of the duodenum. It is covered in front by the beginning of the transverse colon. It lies posteriorly on the common bile duct, inferior vena cava and right renal vein. The uncinate process is that portion of the pancreas which projects upward and backward behind the neck. It is separated from the

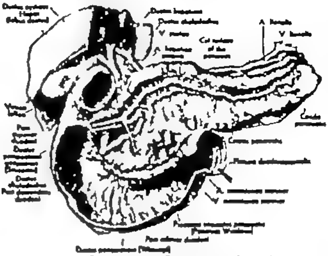


Fig. 794. Excretory ducts of the liver and pancreas. (Spalteholz.)

latter by the superior mesenteric vessels. The neck is about an inch long. It is situated in front of the uncinate process and the beginning of the portal vein. The body proceeds across the second lumbar vertebra and passes upward toward the [illegible]. It is in relation posteriorly with the aorta having the celiac axis above and the superior mesenteric artery below. Both these vessels pierce the gland. It then lies upon the left crus of the diaphragm, the left adrenal and the left kidney and its vessels. It is separated from the posterior surface of the stomach, which it supports, by the lesser peritoneal sac (omental bursa). The tail projects toward the gastric surface of the spleen.

Blood Vessels and Lymphatics. The arterial supply is derived from: (a) the pancreaticoduodenalis, a branch of the gastroduodenal; (b) the inferior pancreaticoduodenalis, a branch of the superior mesenteric; and (c) some branches from the splenic artery. The lymphatics drain into the following nodes:

(a) Left gastric (coronary)
(b) Subpyloric
(c) Mesenteric and
(d) Suprapancreatic (pancreaticosplenic)

The lymphatics of the pancreas and those of the gallbladder and biliary passages freely intercommunicate, this being the reason why chronic pancreatitis often follows cholecystitis and cholangitis.

The Pancreatic Ducts. The chief excretory duct of the pancreas is the duct of Wirsung or ductus pancreaticus, which beginning near the end of the tail runs through the middle of the organ toward its head and then terminates, in most instances, into

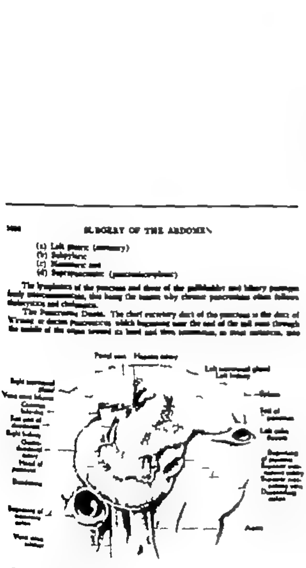


Fig. 795. Anterior aspect [illegible] the organ [illegible] and [illegible] of left kidney [illegible] peritoneum has been removed. (Toldt.)

the floor of the ampulla of Vater. The biliary papilla presents one opening which is common to the pancreatic and common bile duct. Sometimes both ducts empty into the duodenum separately and at other times the pancreatic duct joins the common bile duct outside the duodenal wall in which case both the ampulla and the papilla are absent.

The duct of Santorini or accessory pancreatic duct comes mainly from the lower portion of the head of the pancreas and empties separately in the head of the duodenum [illegible] of an inch above the papilla. It communicates with the duct of Wirsung in the substance of the pancreas.

METHODS OF SURGICAL APPROACH TO THE PANCREAS

There are several routes by which the pancreas may be reached (Figs. 796-797):

1. Through the gastrohepatic omentum above the stomach.
2. Through the gastrocolic omentum below the stomach.
3. Through the transverse mesocolon back of the colon and stomach;
4. By retracting around the second part of the duodenum.

Fig. 796. Approach to the head of the pancreas through the [illegible] [illegible] the superior mesenteric vein. Approach to the body of the pancreas [illegible] through the gastrohepatic ligament. (After Lobker, Leipzig [illegible].)

5. By mobilizing the duodenum to expose the posterior part of the head of the pancreas.
6. Reaching the tail of the gland by raising the stomach, pushing the splenic flexure of the colon downward and inward and incising the reflection of the peritoneum passing from the colon to the abdominal wall;
7. From the loin behind the peritoneum (this dorsal approach is to spare large vessels [illegible]). It is only to be used for [illegible] abscess.)
8. Through the stomach.

Bund [illegible]—Arch. f. Klin. Chir., [illegible]

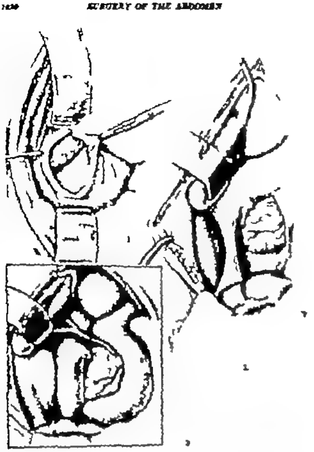


FIG. [illegible]. Exposure of the pancreas [illegible] [illegible]

The chief dangers encountered in operations on the pancreas are (a) hemorrhage (b) escape of pancreatic juice and (c) pancreatic asthenia [illegible]. The pancreas when incised or injured bleeds freely. The vessel walls are friable and difficult to ligate. Tamponade (temporary) usually controls bleeding from the pancreas. Free drainage should always be inserted in all operations on the pancreas. [illegible]

INJURIES TO THE PANCREAS

STAB AND GUNSHOT WOUNDS

Operation must be undertaken without delay

Step 1. Explore for injury to other organs

Step 2. Repair damage to contiguous structures.

Step 3. [illegible]

Comment. [illegible]

Injury to the Pancreas Without External Evidence

[illegible]

RUPTURE OF THE PANCREAS

Comment. [illegible]

[illegible]

[illegible]

OPERATIONS FOR PANCREATITIS

ACUTE NECROSIS OF THE PANCREAS

Anesthesia. If not contra-indicated, spinal anesthesia is advisable.

Step 1. [illegible]

Step 2. [illegible]

Step 3. [illegible]

Step 4. [illegible]

Step 5. [illegible]

Step [illegible]. Close the abdominal wound partially. [illegible]

SUBACUTE PANCREATITIS

[illegible]

OPERATIONS FOR CHRONIC PANCREATITIS

[illegible]

[illegible]

[illegible]

The methods in use depend for the relief of chronic pancreatitis are

Cholecystostomy

Cholecystoenterostomy

Cholecystostomy or cholecystoduodenostomy supplemented by drainage of the common bile duct.

[illegible]

Comment. [illegible]

PANCREATIC EDEMA

[illegible]

(a) Multiple incisions at various points

(b) Tamponade

(c) Cholecystostomy

[illegible]

[illegible]

bladder behind gives the surgeon the assurance of an avenue for subsequent cholecystostomy should such emergency arise. Archibald advises in cases of persistent recurring attacks of pancreatitis to divide the sphincter of Oddi as means of [illegible] permanent drainage of bile. His experimental work on animals [illegible] him of the efficacy of such procedure although he tried it only on one human being.

OPERATIONS FOR PANCREATIC STONES

PANCREOLITHOTOMY

Historical Notes. [illegible] noted this condition as early as [illegible]. Graaf records the occurrence of stones in the pancreatic duct. Later [illegible] in [illegible], Galeati, in 1754 Morgagni, in 1761 Cowley, and in [illegible] Cawley substantiated the finding of stones in the pancreatic duct.

Stones in the pancreas are rare. If diagnosed by [illegible] the operation is performed as follows (Haye-Rahson):

Step 1. Make an incision 3 to 4 inches long, about an inch to the right of the midline.

Step 2. The papilla of Vater is laid open, its edges are caught with Allis forceps and drawn into the wound.

Step 3. The duct of Wirsung is explored with probes and concretions removed by proper-sized forceps. If the stones are more deeply placed in the ducts, [illegible] suggests approaching the pancreas through the gastrohepatic omentum or through a slit in the transverse mesocolon. By "separating bluntly the duodenum from the pancreas, the back of the pancreas may be readily reached" (Rahson). The calculi are then exposed by incising the structures overlying them and are then extracted with forceps or scoop.

Step 4. Hemorrhage is arrested by [illegible] ligatures.

Step 5. The duct is sutured with fine catgut sutures, the gland substance sutured with linen sutures and the capsule repaired.

Step 6. Drainage should be instituted (tube or cigaret drains).

OPERATIONS FOR PANCREATIC CYSTS

[illegible], Mayhorne and [illegible] give the following classification of pancreatic cysts:

I. Cysts resulting from defective development
1. Cysts in infants
2. Cysts associated with polycystic disease of the kidney
3. Dermoid cysts
4. [illegible] cysts

II. Cysts resulting from tumors

III. Retention cysts

IV. Neoplastic cysts
1. Cystadenoma
2. Cystadenocarcinoma
3. Teratomatous cysts

V. Cysts resulting from parasites

No matter what variety of pancreatic cyst one encounters, operation is always indicated (Figs. [illegible]). In view of the fact that many of these cysts have been known to develop into malignant conditions later, the earlier the cyst is subjected to surgical therapy the better. The accepted methods of treatment at the present time are:

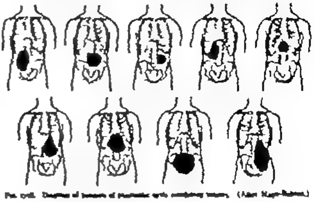


Fig. [illegible]. Diagram of location of pancreatic cysts simulating tumors. (After Haye-Rahson.)

(a) Marsupialization. This consists of the following steps:

1. Incision over the most prominent part of the tumor.
2. Proper exposure of the cyst.
3. Small incision into the cyst wall with introduction of an aspirator for evacuation of the fluid.
4. Exploration of the interior of the sac and ascertaining the relation of the cyst wall to the pancreas.
5. Suturing the edges of the incision in the cyst sac to the edges of the abdominal wound.
6. Drainage.

(b) Extirpation. In cystadenomata extirpation is the rule. Complete excision is the ideal treatment. Although the latter is quite a difficult procedure, entailing mature surgical judgment and much dexterity, it often happens, and this is fortunate, indeed, that pancreatic tumors are surrounded by a dense fibrous capsule which may on occasion be shelled out of the pancreas without serious damage to the parenchyma. The danger of hemorrhage of course must always be kept in mind. Careful operating, calm and painstaking step by step procedure will often be rewarded by success. A line of cleavage between the tumor and pancreas is often difficult to ascertain. In such cases, there is great danger of hemorrhage and setting up of acute pancreatitis. "For these reasons," E. Archibald admonishes in speaking of this class of cases, "attempts at extirpation must

often be abandoned even when one has succeeded in loosening the cyst wall almost down to its origin in the pancreas. Then it is better to abandon it unless by good luck the shelling out process should be found to be easy. It is on the whole advisable to open the cyst wall at the beginning and investigate the interior with the finger. If, at the junction, one finds the papillomatous masses, one may attempt extirpation, but if the entire inner lining of the cyst is smooth one should assume that the case is one of pseudocyst and one had then better do simple drainage with marsupialization for the latter is undoubtedly much the safer procedure."

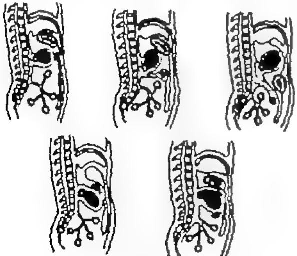


Fig. [illegible]. [illegible] (Haye-Rahson.)

One must remember that marsupialization is often followed by infection. Again one must not lose sight of the fact that it is much easier to cope with an infection with hopes for final closure of the sinus than subject the patient at the time of operation to a major procedure which may cost his life.

Wohlgemuth [illegible] of persistent discharging fistula will frequently yield to properly regulated antidiabetic diet. In some cases, marked success has followed Wohlgemuth's procedure. In others, it has failed.

[illegible] devised an ingenious operation in this class of cases which consists of dissecting out the fistulous tract and implanting it into the [illegible] bowel or the stomach. Successful reports have followed this procedure, particularly in long-standing cases.

Figure [illegible] depicts the case of a [illegible] pancreatic cyst extirpated by the author. Recovery followed. The microscopic examination of the cyst wall revealed the following:

The wall of the cyst is lined by a high columnar mucous producing cell. Underneath the epithelium there are pancreatic acini with occasional islands of

Fig. [illegible]. [illegible] pancreatic cyst extirpated by the author. Recovery. [illegible]

Langerhans. In some places the epithelium changes its character somewhat, becoming more polygonal and extending into the underlying tissue where they show some irregular pattern. Here some brownish blood pigment is contained in mononuclear cells. Round cells are seen throughout the wall.

Cysts Within the Pancreas

There are two methods of treatment: return to the abdominal drainage [illegible]

… in all cases. As for results and prognosis, the discovery and removal of all the islet tumor tissue gives "brilliant and lasting cures of the hypoglycemic state." In thirteen of Whipple's cases there was only one death, and the latter in a patient with carcinoma of the islands (personal communication). This is, indeed, a brilliant achievement taking into consideration that up to the present no material help was offered to these patients.

RETROPERITONEAL TUMORS

Retroperitoneal neoplasms which are solid may be either lipomas or sarcomas. The operative procedure is the same for both. If sarcoma is recognized, it is rarely removed unless its removal relieves the patient of extreme pain.

Lipomas originate usually from the perirenal and mesenteric fat and sometimes become enormous in size.

In their development retroperitoneal tumors thrust the intestines toward the front or side; they may grow into the mesentery and they sometimes surround organs like the kidneys, vena cava, etc. Diagnosis is rarely established before the abdomen is opened.

In operating (a) obtain sufficient exposure so that removal, if indicated, may be done under ocular guidance. (b) Incise the peritoneum over the tumor so as not to injure the intestines or blood vessels. (c) In removing a growth from the iliac veins, vena cava or similar structures, rather leave a part of the growth than injure these structures. If any of the important blood vessels have become injured accidentally repair them without delay. (d) If a kidney is involved, it should be removed, provided the other organ is in good condition (ureteral catheterization, functional tests, pyelography, etc.).

CHAPTER 37

SURGERY OF THE SPLEEN

Anatomic Considerations. (Figs. [illegible]) The spleen is situated in the left hypochondrium behind the stomach, beneath the tenth, ninth and eleventh ribs.

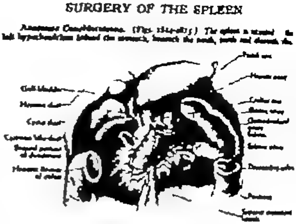


Fig. [illegible]. The pancreas and spleen. (Davis, Applied Anatomy.)

The average weight of the spleen in man is approximately seven ounces (Gray's). Its shape is principally determined by the [illegible] of the splenic flexure of the colon.

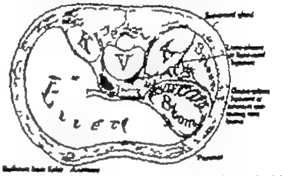


Fig. [illegible]. Diagrammatic representation of the important surgical relations of the spleen. (Courtesy of Dr. D. C. Balfour.)

Many times it lies … [illegible] … The spleen is completely surrounded by peritoneum. It … [illegible]

the gastrosplenic omentum (ligament) containing the vasa brevia and the left gastro-epiploic vessels, and the lienorenal ligament carrying the splenic artery and vein. The splenic vessels are frequently attached to the tail of the pancreas. It is well to remember that the spleen is situated behind the stomach rather than to the left of it. The highest level of the spleen is opposite the body of the ninth thoracic vertebra, its lowest level opposite that of the first or second lumbar vertebra.

Relations. The diaphragmatic surface of the spleen is in relation with the diaphragm and the ninth, tenth and eleventh ribs. The renal surface is in contact with the left kidney, while its gastric surface shows an impression from the tail of the pancreas and the stomach. The basal surface rests upon the splenic flexure of the colon and the phrenicocolic ligament. The hilum is on the gastric surface.

Arteries of the Spleen. The splenic artery is a large tortuous vessel, a branch of the celiac axis. It breaks up about an inch from the spleen, into six or more branches. These enter the hilum one above another. The branches of the splenic artery do not anastomose with one another. The main branch, after leaving the celiac axis passes behind the lesser peritoneal sac (omental bursa) along the upper margin of the body of the pancreas and in front of the left suprarenal body and kidney. [illegible] … The splenic veins accompany the arteries; their branches unite to form the splenic vein.

The Lymphatics. The deep set emerge from the hilum and after picking up the superficial lymph vessels empty into a small group of lymph nodes at the tail of the pancreas.

INJURIES TO THE SPLEEN

While tamponade and suture have their champions in the treatment of injuries to the spleen, splenectomy is coming more and more to the fore as the method of choice in the treatment of severe rupture of the spleen. It was first successfully performed in 18[illegible] by Riegner.

SUTURE OF THE RUPTURED SPLEEN

Suture of the spleen is indicated where the tear is small and the condition appears remediable. Heavy catgut sutures are used; they are introduced some distance from the edge of the tear. Various locked mattress suture may be resorted to … [illegible] … The method for placing this suture is as follows:

Step 1. Insert a long needle armed with heavy catgut through the spleen approximately one-half inch from the lacerated edge. Traverse the rent at an equal distance on the opposite side to a point corresponding to the entrance point. Direct the needle straight through.

Step 2. Introduce the needle three-quarters of an inch from the last point of exit on the same side of the rent and direct it back again through the spleen.

Step 3. Traverse the rent as before but in the opposite direction making the needle exit on the same side of the rent as it first entered and immediately opposite the point where it was inserted on the opposite side.

Step 4. Tie the ends together loosely. Pass the suture under the strand opposite … [illegible] … In this way two parallel strands are locked across the incision. When this is tied, the torn edges are approximated and hemorrhage is checked.

SPLENECTOMY FOR RUPTURE

Step 1. Reach the spleen through a left transverse incision beginning at the left costal margin and extending downward to a distance sufficient to afford adequate exposure.

Step 2. Pass the left hand into the opened abdomen and palpate the injured organ. Seek the pedicle at once. Compress it in the fingers thus temporarily arresting hemorrhage. Retract the wound to the left.

Step 3. Aspirate the escaped blood, or mop it away with gauze packs.

Step 4. Deliver the spleen into the wound, still exerting digital pressure on the pedicle. Should delivery of the spleen be hampered by adhesions, these must be divided under ocular control. If the incision is inadequate, it should be enlarged by a transverse limb extending to the left. Pack the small gut out of the way. Pulling on the greater curvature of the stomach usually brings the spleen to view. A body elevator on the operating table is a great aid to bring the operative field into better position.

Treatment of the Pedicle. This may be divided between clamps and ligatured en masse, or by separate clamping and individual ligation. Each method has its protagonists. I personally prefer mass ligation supplemented by additional [illegible] of the pedicle by as many ligatures as needed. Stout catgut or silk may be used. An important point to remember is, to ligate close to the hilum even at the expense of leaving a portion of spleen tissue behind, instead of jeopardizing an often shorter pedicle.

Step 5. Clear the abdominal cavity of clots.

Step 6. Explore the other organs (liver, kidneys, etc.) for possible injury.

Step 7. Close the abdomen in layers.

Transfuse the patient when indicated.

OPERATIONS FOR FLOATING SPLEEN

SPLENOPEXY

This consists of anchoring the spleen in cases of wandering or floating spleen. There are a number of methods of accomplishing this. Andersson [illegible] Rydygier priority for publishing the first case in 18[illegible], although Tuffier claimed to have done the operation in 18[illegible].

Rydygier's Method

Step 1. Open the abdomen, freely exposing the spleen.

Step 2. Make a transverse incision through the parietal peritoneum between the tenth and tenth ribs.

Step 3. With the fingers introduced through this incision, separate the peritoneum from the parietes, below the incision. A pocket thus results with its mouth directed upward. The space is made sufficiently large to accommodate the lower half of the spleen. If the entire spleen is deposited into pouch thus produced, its weight may enlarge it to such extent as to render the operation a failure. To avoid this eventuality, four catgut sutures through the peritoneum and part of the overlapping parietes, immediately below the lower limit of the pouch. This will prevent further separation of the pari-

toneal flap from the abdominal wall. After placing the lower end of the spleen into the pocket produced,

Step 4. Sew the edges of the peritoneal flap forming the pouch, and suture them to the gastro-splenic ligament by one or more catgut sutures.

Step 5. Close the abdomen in layers.

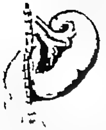


Fig. 1806. Bland-Sutton method of splenopexy. [illegible]

Bardenheuer Method

Step 1. Make an incision, after the patient is placed on the right side, extending from the tenth rib to the iliac crest, in the axillary line.

Step 2. At the level of the tenth rib, an incision is made at right angles to the first.

Step 3. Divide the soft tissues down to the peritoneum.

Step 4. Strip the peritoneum up over an area rather larger than that of the spleen.

Step 5. Open the peritoneum, explore and bring the spleen out through this opening.

Step 6. Suture the peritoneal wound around the retroverted spleen and to the pedicle of the spleen. It is advised, by some, to pass a stout suture through the lower end of the spleen which is tied around the tenth rib.

Step 7. Close the wound in the soft parts.

Comment. At the close of this operation, when properly performed, the spleen lies in a retroperitoneal pouch, its pedicle is fixed to the peritoneal wound and its body is suspended from the tenth rib.

Bland-Sutton method of splenopexy is depicted in Fig. 1806.

Kouwer's Method

This consists of causing adhesions to form between the spleen and its surroundings, the result of tamponade.

SURGERY IN ABSCESSES, CYSTS AND TUMORS OF THE SPLEEN

The operative procedures here consist of

Evacuation and drainage (splenotomy)

Removal of the the spleen (splenectomy).

If the pleura is obliterated by adhesions, the abscess may be reached by the transpleural route. Fopping and Harrington advise a posterior approach through an incision commencing at the tip of the twelfth rib, upward and along the edge of the eleventh rib. Or the tenth rib (about three inches) is resected in the posterior axillary line, the diaphragm is perforated and the abscess cavity entered. When the lower pole is chiefly involved in the suppurative process, an anterior approach is best. This may be accomplished in one or two stages.

Splenectomy should only be resorted to where there is a comparative absence of adhesions and where the operative risk is minimal.

In cysts, splenectomy is not always necessary. In fact, it may be contra-indicated. In tumors, removal of the spleen is the only recourse.

Step 1. Open the abdomen.

Step 2. Isolate the spleen from the rest of the peritoneal cavity by means of laparotomy sponges.

Step 3. Ascertain the position of the abscess by means of an exploratory needle.

Step 4. Where pus is found, incise the spleen and evacuate the pus.

Step 5. Drain with rubber tube and tampon. Tamponade must be voluminous so as to isolate the spleen from the rest of the abdomen.

Step 6. Close the abdomen leaving sufficient drainage space particularly at the upper and lower angles.

Splenectomy

Conditions which may require removal of the spleen are as follows:

1. Anomalies of position (excessively mobile spleen)
2. Injuries
   - Wounds
   - Lacerations
   - Rupture from trauma
   - Spontaneous rupture
3. Tumors of various types
4. Suppurations
5. Infections
   - Tuberculosis
   - Malaria
   - Syphilis
6. Splenomegaly from many causes, as
   - Chronic infectious diseases
   - Idiopathic (?) splenomegaly
   - Banti's disease
   - von Jacksch's disease
   - Cirrhosis of the liver
   - Hemolytic jaundice
   - Purpura hemorrhagica
   - Thrombophlebitis of the splenic vein
   - Hemolytic anemia of obscure etiology

Splenectomy may be an operation of extreme simplicity or beset with almost insurmountable hardships.

The patient is placed in the exaggerated Mayo-Robson position (inclined laterally).

Step 1. Make a median incision beginning at the xiphoid cartilage and continuing it downward for a distance commensurate with the size of the spleen to be removed. Balfour advocates a left Bevan incision (Fig. 1817).

Step 2. Thorough inspection and exploration are essential. Do not sever adhesions blindly. The attachments of the spleen by adhesions to the omentum, colon and abdominal wall should be doubly ligated and divided under visual observation. Adhesions to the diaphragm present serious difficulties in many cases. Balfour admonishes, "in the late stages of splenic anemia, all adhesions to the anterior border of the spleen, which may be not only numerous, but also contain large venous trunks, should be divided between ligatures." This should be done with extreme gentleness, because any rough handling of the adhesions is not only liable to tear the friable spleen, but likely to tear the spleen and engage the attention of the surgeon unnecessarily as well as obscure the operative field. Joel Harrington, in the past, advised, in cases of marked adhesions of the upper pole of the spleen, to abandon the operation, otherwise disaster is invited. This admonition has been disregarded by most surgeons, and such adhesions are severed with the fingers and temporarily compressed by hot lap sponges (Fig. 1818). If the adhesions have required ligation, these are temporarily clamped and dealt with later.

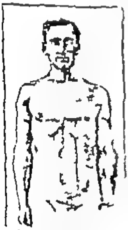


Fig. 1817. Splenectomy. Incision in [illegible] spleen. (Courtesy of Dr. D. C. Balfour.)

Step 3. Deliver the spleen into the wound leaving it for the moment suspended on its pedicle. A large hot lap sponge is introduced into the space previously occupied by the spleen. As many additional lap-packs as are necessary to temporarily arrest hemorrhage are superimposed on the first lap-pack. W. J. Mayo pointed out that these packs effectually arrest venous oozing and obviate subsequent ligation, if left in situ for a sufficient time (until the splenectomy is completed). In cases where the spleen is mobile, the pedicle may be ligated by simple transfixion. A clamp is applied to the pedicle near the spleen and the pedicle is divided between the ligature and the clamp and the spleen removed. Federoff's method consists of clamping the pedicle of the spleen with two clamps as is practiced in the case of nephrectomy.

The structures carrying the vessels to the spleen are, as stated above, the gastrosplenic omentum and the lienorenal ligament (Fig. 1819).

When the spleen is not mobile, ligation of the pedicle en masse is impossible without simultaneously ligating the tail of the pancreas. Under such conditions

rotate the spleen toward the left, exposing the omentum and ligaments carrying the blood vessels: the vasa brevia and the left gastro-epiploic vessels course in the gastro-splenic omentum from the splenic artery to the stomach. These vessels are carefully ligated (doubly) and divided together with the gastrosplenic omentum, as close as possible to the spleen (Figs. 1820-1821). Balfour emphasizes that in dealing with the upper edge of the gastrosplenic omentum it must be remembered that here the fundus of the stomach is normally in very close apposition to the spleen. A number of surgeons have reported operative in-

Fig. 1818. Splenectomy [illegible]. Position of gauze pack. (Courtesy of Dr. D. C. Balfour.)

juries to the stomach. In ligating friable vessels, some catgut suture is preferable to finer material which tends to cut through the vessel wall.

Step 4. When one feels assured that the pedicle is securely controlled, the gauze packs beneath the diaphragm are removed. If bleeding occurs, a suture carried on a long needleholder is made to surround the bleeding point which is ligated. Raw surfaces are sutured and the abdomen is closed.

Comment. Discussing hemostasis during splenectomy, Walter D. Wise[1] reviews the following salient points. As already pointed out in another section of this work, the removal of the spleen may be a simple procedure or may be beset with many difficulties. With a free splenic pedicle, the former pertains. In cases of long-standing disease where the spleen is much enlarged and bound down by many adhesions and is accompanied by a diseased liver, serious difficulties may be encountered. Wise points out that in a well developed case of Banti's disease as well as in other conditions, the blood vessels of the spleen may be enlarged, tortuous and short, while the

[1] Annals of Surgery, 1922.

greater curvature of the stomach, the tail of the pancreas and the splenic hilus are in close approximation. Under such conditions, the classical methods of clamping and ligation or ligation by the use of the ligature carrier [illegible] do not work out well, because the vessels are so short and easily injured, that neither of the methods mentioned is free from danger of profuse hemorrhage or from injury to the stomach and pancreas. Also, in traumatic rupture of a normal spleen, the operation is often simple, but rupture, traumatic or spontaneous, of a much enlarged, diseased and adherent spleen is often quite a serious problem. In a case of well advanced Banti

Fig. [illegible]. Splenectomy. Blood vessels of the spleen. (Courtesy of Dr. D. C. Balfour.)

disease with large tortuous vessels in the pedicle of the spleen and in another case of Banti disease with spontaneous rupture of a spleen weighing [illegible] Gm., Wise used a method of dealing with the pedicle which seemed [illegible] and greatly simplified the operation.

The spleen was freed from its adhesions, lifted up and a large hot pack placed in its fossa. The pedicle was clamped with a rubber-covered intestinal clamp far away from the spleen. If the pedicle is short, there is grave danger of including some part of the stomach and the pancreas. If one proceeds as pointed out, complete control of hemorrhage is obtained and the tail of the pancreas can be freed from the splenic hilus, if necessary, and the vessels in the pedicle ligated at the option of the surgeon.

geon. The rubber-shod clamp avoids injury to the stomach and even though the pancreas is compressed by it for a few minutes, no damage results.

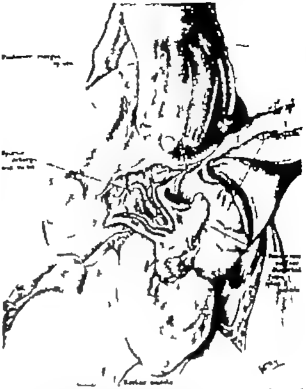


Fig. [illegible]. Splenectomy. Method of dealing with the vessels of the spleen. (Courtesy of Dr. D. C. Balfour.)

Wise further stresses that when the vasa brevia are tied individually and close to the greater curvature of the stomach, one feels some apprehension that during an attack of severe vomiting, the ligatures may become dislodged, particularly if catgut is used, causing severe hemorrhage. He

further counsels for the sake of greater security that the vessels after being ligated individually be buried with a purse-string suture of silk down to the

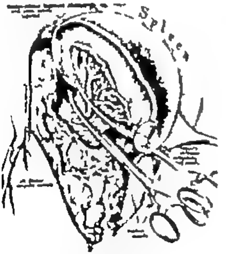


Fig. [illegible]. Splenectomy. Clamps and ligatures in ablating the spleen. (Courtesy of Dr. D. C. Balfour.)

border of the stomach. While this may appear as a minor point, the possibility of a second hemorrhage may be prevented by its use.

CHAPTER 38

HERNIA

Anatomic Considerations. The structures concerned in operations for oblique inguinal hernia are the following. (Figs. [illegible].)

The skin, subcutaneous fat and superficial fascia. In dividing these structures the following blood vessels are encountered:

(a) The superficial epigastric, (b) the superficial external pudic and (c) the superficial circumflex iliac. These are all branches of the femoral.

The aponeurosis of the external abdominal oblique muscle and its contiguous structure, viz. the external abdominal ring, which is a triangular aperture in the aponeurosis of the external oblique muscle. It serves as the place of exit of the spermatic cord. It is bounded laterally and medially by a thickening of the fibers of the external abdominal oblique fascia called respectively the external and internal pillars. The external pillar is continuous with Poupart's ligament (ligamentum inguinale) and is attached to the spine of the os pubis. The internal pillar is attached to the anterior surface of the body of the pubic bone. The hypogastric branch of the iliohypogastric nerve emerges, just above and somewhat medially to the external inguinal ring, by perforating the aponeurosis of the external abdominal oblique muscle. The pillars are reinforced by the intercrural fibers.

The Internal Oblique, Transversalis Muscle and "Conjoined Tendon." The arched fibers of the internal oblique muscle take origin from the outer third of Poupart's ligament and arching over the spermatic cord are inserted into the outer edge of the sheath of the rectus abdominis muscle. Its inferior portion joins the transversalis muscle becoming tendinous and forms the conjoined tendon which is inserted into the crest of the os pubis and pectineal line. The ilio-inguinal nerve courses along the surface of the internal oblique muscle.

Fig. [illegible]. [illegible] (Collection of [illegible])

The cremasteric muscle and cremasteric fascia form a series of curved loops which become longer as they progress downward, the lowermost reaching the testis and becoming attached to the tunica vaginalis. These muscular loops are held together by the cremasteric fascia.

The Spermatic Cord (funiculus spermaticus). Its principal structures are (a) the spermatic artery, (b) the spermatic veins (plexus pampiniformis) and (c) the vas deferens. The spermatic artery is a branch of the aorta. The right spermatic vein empties into the inferior vena cava. The left spermatic vein empties most frequently into the left renal vein. It is well to remember that the vas deferens is supplied by a fine vessel, the arteria deferentialis, derived from the middle or inferior vesical artery. The fascial and muscular structures of the cord derive their blood supply from the deep epigastric and other vessels.

The processus vaginalis plays an important role in congenital hernia which develops when the process remains open. In the adult it is found obliterated as a cord of tissue within the spermatic cord. The nerves of the spermatic cord are derived from the spermatic and the genital branch of the genitofemoral nerve. The lymph vessels empty into the iliac and lumbar vessels.

The coverings of the spermatic cord are composed of a fibrous sheath formed by the continuation of the structures of the abdominal wall through which the cord passes. These from within outward are (a) the internal spermatic fascia, (b) the

[illegible]

Fig. [illegible]. Right inguinal canal in the male (second layer), viewed from in front. (Spalteholz.)

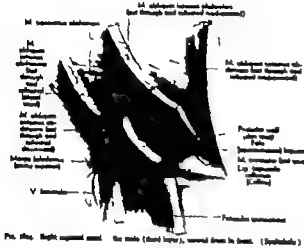


Fig. [illegible]. Right inguinal canal in the male (third layer), viewed from in front. (Spalteholz.)

cremasteric fascia and muscle (from the internal oblique) and ( ) the intercolumnar fascia (from the external oblique muscle).

Poupart's ligament (lig. ilio-inguinale) extends from the anterior superior spine of the ilium to the spine of the os pubis.

The deep epigastric artery plays an important rôle as a landmark in determining whether a hernia is direct or indirect.

Hesselbach's triangle is bounded internally by the outer margin of the rectus abdominis muscle, externally by the deep epigastric artery and below by the inner half of Poupart's ligament. Examined from within the abdomen this space is seen delineated by three folds. In the central fold lies the urachus, in the outer fold the deep epigastric artery and between the two the obliterated hypogastric artery. There are three depressions between these folds: the outer depression (external inguinal fossa) is situated to the outer side of the deep epigastric artery and

Fig. [illegible]. Posterior wall of the right inguinal canal in the male, viewed from behind. (Spalteholz.)

corresponds to the site of the internal abdominal ring. The middle depression (middle inguinal fossa) lies between the deep epigastric and the obliterated hypogastric arteries, while the inner depression (internal inguinal fossa) lies between the obliterated hypogastric artery and the urachus. An oblique or indirect inguinal hernia always passes through the external inguinal fossa. A direct inguinal may pass through the middle or internal inguinal fossa (Fig. [illegible], p. [illegible]).

The Transversalis Fascia, Internal Inguinal Ring, Properitoneal Fat and Peritoneum. Normally the peritoneum smoothly covers the upper surface of the internal inguinal ring. In case of hernia, the peritoneum bulges into and through the internal inguinal ring.

The inguinal canal is the channel through which the spermatic cord and an indirect inguinal hernia pass. Its proximal opening [illegible] depression in the transversalis fascia, the so-called internal inguinal ring; its distal opening is the external inguinal ring. Its posterior wall is made up of the transversalis fascia, upon which courses the deep epigastric artery, and the falx inguinalis. Its inferior boundary is Poupart's ligament. It is covered by the internal oblique muscle at its external extremity and for the rest of its extent it is covered by the aponeurosis of the external oblique muscle only.

The femoral point lies medial to the midpoint of Poupart's ligament where the external iliac artery becomes the femoral.

INGUINAL HERNIA

OPERATIONS FOR INDIRECT (OBLIQUE) ACQUIRED INGUINAL HERNIA

(Herniotomy—Herniorrhaphy—Hernioplasty)

Bassini Operation

Anesthesia. General, infiltration or spinal.

Local Anesthesia (Figs. [illegible]). Outline two wheals (Points and) through which the four needle punctures are made. Point is about three fingers

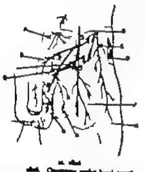
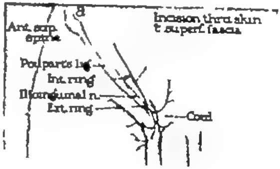


Fig. [illegible]. Operations under local anesthesia for the radical cure of inguinal hernia. [illegible]

Fig. [illegible]. [illegible]

breadth medial from the anterior superior spinous process of the ilium, while point lies directly opposite the pubic bone outside of the external inguinal ring. Inject about 10 cc. of the anesthetic solution (about ½ per cent novocaine) into the musculature situated between point and the anterior superior spinous process of the ilium. In so doing, introduce the needle through the aponeurosis of the external abdominal oblique muscle and while depositing the solution, direct the needle obliquely toward the anterior superior spinous process, moving the needle forward until the point of the needle reaches the iliac crest.

The next step consists of taking a long needle which is introduced through



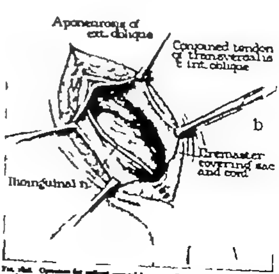


Fig. [illegible]. Operation for indirect inguinal hernia. [illegible]

greater curvature of the stomach, the tail of the pancreas and the splenic hilus are in close approximation. Under such conditions, the classical methods of clamping and ligation or ligation by the use of the ligature carrier "do not work out well," because the vessels are so short and easily injured, that neither of the methods mentioned is free from danger of profuse hemorrhage or from injury to the stomach and pancreas. Also, in traumatic rupture of [illegible] normal spleen, the operation is often simple, but rupture, traumatic or spontaneous, of [illegible] much enlarged, distorted and adherent spleen is often quite [illegible] serious problem. In [illegible] case of well advanced Banti's

Fig. [illegible] Splenectomy. Blood vessels of the spleen. (Courtesy of Dr. D. C. Balfour.)

disease with large tortuous vessels in the pedicle of the spleen and in another case of Banti's disease with spontaneous rupture of [illegible] spleen weighing [illegible] Gm., Wise used [illegible] method of dealing with the pedicle "which seemed safe and greatly simplified the operation."

The spleen was freed from its adhesions, lifted up and [illegible] large hot pack placed in its fossa. The pedicle was clamped with [illegible] rubber-covered intestinal clamp far away from the spleen. If the pedicle is short, there is grave danger of including some part of the stomach and the pancreas. If one proceeds as pointed out, complete control of hemorrhage is obtained and the tail of the pancreas can be freed from the splenic hilus, if necessary, and the vessels at the pedicle ligated at the spleen of the [illegible]

gans. The rubber-shod clamp avoids injury to the stomach and even though the pancreas is compressed by it for [illegible] few minutes, no damage results.

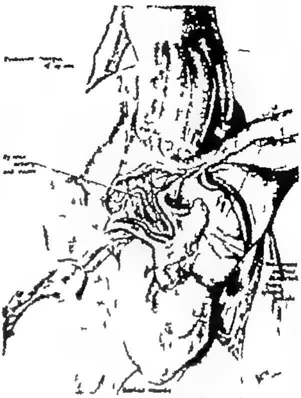


Fig. [illegible] Splenectomy. Method of dealing with the vessels of the spleen. (Courtesy of Dr. D. C. Balfour.)

Wise further stresses that when the vasa brevia are tied individually and close to the greater curvature of the stomach, one finds some apprehension that during an attack of severe vomiting, the ligatures may become dislodged, particularly if catgut is used, causing severe hemorrhage. He

further contends for the sake of greater security that the vessels after being ligated individually be buried with [illegible] purse-string suture of silk down to the

Fig. [illegible] Splenectomy. Clamps and ligatures in ablating the spleen. (Courtesy of Dr. D. C. Balfour.)

border of the stomach. While this may appear at [illegible] minor point, the possibility of [illegible] secondary hemorrhage may be prevented by its use.

CHAPTER 38

HERNIA

Anatomic Considerations. The structures concerned in operations for oblique inguinal hernia are the following (Figs. [illegible]):

The skin, subcutaneous fat and superficial fascia. In dividing these structures the following blood vessels are encountered:

( ) The superficial epigastric, (b) the superficial external pudic and (c) the superficial circumflex iliac. These are all branches of the femoral.

The aponeurosis of the external abdominal oblique muscle and its important structure [illegible] the external abdominal ring, which is [illegible] triangular aperture in the aponeurosis of the external oblique muscle. It serves as the place of exit of the spermatic cord. It is bounded laterally and medially by [illegible] thickening of the fibers of the external abdominal oblique fascia called respectively the external and internal pillars. The external pillar [illegible] continuous with Poupart's ligament (ligamentum inguinale) and [illegible] attached to the spine of the os pubis. The internal pillar [illegible] attached to the anterior surface of the body of the pubic bone. The hypogastric branch of the iliohypogastric nerve emerges just above and somewhat medially to the external inguinal ring, by perforating the aponeurosis of the external abdominal oblique muscle. The pillars are connected by the intercrural fibers.

Fig. [illegible] [illegible] (Courtesy of Prof. [illegible])

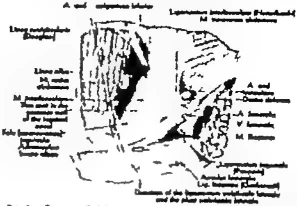
The Internal Oblique, Transversalis Muscle and "Conjoined Tendon." The arched fibers of the internal oblique muscle take origin from the outer third of Poupart's ligament and arching over the spermatic cord are inserted into the outer edge of the sheath of the rectus abdominis muscle. Its inferior portion joins the transversalis muscle becoming tendinous and forms the conjoined tendon which is inserted into the crest of the os pubis and pectineal line. The ilio-inguinal nerve courses along the surface of the internal oblique muscle.

The cremasteric muscle and cremasteric fascia form [illegible] series of curved loops which become longer as they progress downward, the lowermost reaching the testis, and becoming attached to the tunica vaginalis. These muscular loops are held together by the cremasteric fascia.

The Spermatic Cord (funiculus spermaticus). Its principal structures are: (a) the spermatic artery, (b) the spermatic veins (plexus pampiniformis) and (c) the vas deferens. The spermatic artery [illegible] branch of the aorta. The right spermatic vein empties into the inferior vena cava. The left spermatic vein empties frequently into the left renal vein. It is well to remember that the vas deferens [illegible] supplied by [illegible] [illegible] artery, the arteria deferentialis, derived from the middle or inferior vesical artery. The lateral and muscular structures of the cord derive their blood supply from the deep epigastric and other vessels.

The processus vaginalis plays an important rôle in congenital hernia which develops when the process remains open. In the adult it [illegible] found obliterated as [illegible] cord of tissue within the spermatic cord. The nerves of the spermatic cord are derived from the sympathetic and the genital branch of the genitofemoral nerve. The lymph vessels empty into the iliac and lumbar nodes.

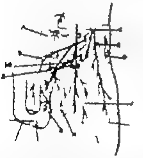
The coverings of the spermatic cord are composed of [illegible] fibrous sheath formed by the continuation of the structures of the abdominal wall through which the cord passes. These from within outward are: (a) the internal spermatic fascia, (b) the [illegible]

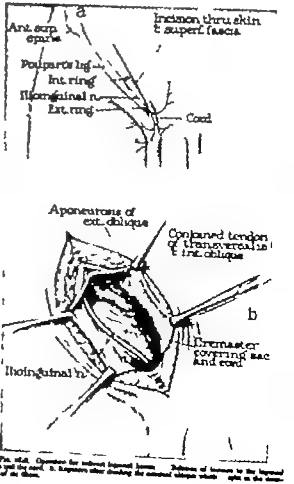


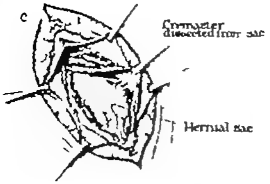
INGUINAL HERNIA

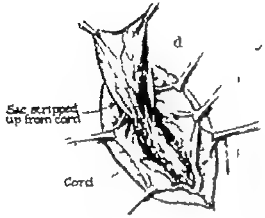
OPERATIONS FOR INDIRECT (OBLIQUE) ACQUIRED INGUINAL HERNIA

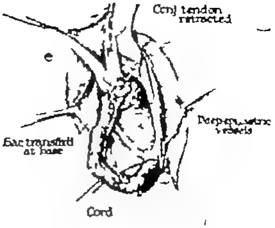
Anesthesia. General, infiltration or spinal.

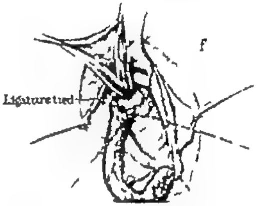


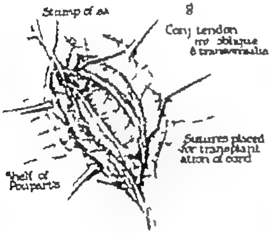


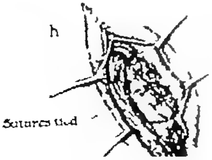

c
Cremaster
dissected from sac
Hernial sac

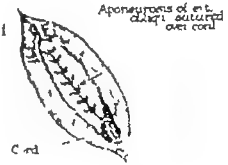

d
Sac stripped
up from cord
Cord


Conj tendon
retracted
e
Deep epigastric
vessels
Sac transfixd
at base
Cord


f
Ligature tied


Stump of sac
g
Conj tendon
int oblique
& transversalis
Sutures placed
for transplant
ation of cord
Shelf of
Pouparts


h
Sutures tied


Aponeurosis of ext.
oblique sutured
over cord
i
Cord


j

point and depositing the anesthetic fluid along both sides of the inguinal canal. The point of the needle may be guided by introducing a finger through the external abdominal ring. Now introduce the needle at point and inject, after the pubic bone has been reached, from 10 to 20 cc of the solution into the inguinal canal, under the fascia.

The illustrations depict the method of procedure (Figs. 1826–827).

Step 1. Incision. Make an oblique incision (Fig. 828) about half an inch above and parallel to Poupart's ligament from a point opposite the anterior superior spinous process of the ilium to the spine of the os pubis.

Step 2. Deepen the incision and expose the fascia of the external abdominal oblique muscle. The incision severs the superficial epigastric vessels running at right angles to it. Ligate these carefully. The superficial external pudic and the superficial circumflex vessels are also encountered. They are all branches of the femoral vessels.

Step 3. Expose and identify the components of the external abdominal (inguinal) ring (external and internal pillars and arcuate fibres). Introduce through the external ring a grooved (or Kocher) director and divide the aponeurosis of the external abdominal oblique muscle from the external ring along the line of incision for two or three inches (Fig. 828 b).

Step 4. Retract the edges of the aponeurotic flaps and separate the upper flap inward and the lower from Poupart's ligament. With the aid of gauze on the index finger or handle of the scalpel strip and expose the lower leaf of the divided external oblique from the underlying structures. The contents of the inguinal canal are now exposed. The ilio-inguinal nerve is seen and avoided.

Step 5. Identify the conjoined tendon (transversalis and internal oblique muscles). Expose, fully by retraction, the structures concerned. Keep in mind the hernial sac and cord.

Step 6. Completely isolate by stripping and dissection, the sac from the spermatic cord (Fig. 828 and d) as high as possible in relation to the internal ring.

Step 7. Open the sac. Examine its contents. If normal, return them to the abdominal cavity. If strangulated, proceed as outlined under strangulated hernia (p. 1040) (Fig. 829).

Step 8. Ligation of the sac (Fig. 1828). Retract the conjoined tendon. Transfix the hernial sac at its base as high as possible with chromic catgut. Avoid injuring the deep epigastric vessels. Tie the ligature (Fig. 1828 f) encircle the neck of the sac and tie the ligature once more.

Step 9. Cut off the redundant sac (Fig. 1828 g). The stump of the sac will retract beyond the internal ring (correct procedure).

Step 10. Introduce a strip of tape under the cord and retract it out of the way.

Step ... Introduce beneath the cord, from below backward and from within outward, successively five or six Ka... isolated catgut sutures uniting the conjoined tendon and transversalis muscle and the lower fibres of the internal oblique with Poupart's ligament. Tie the sutures (Fig. 1828 h). Approximate but do not strangulate the tissues concerned.

Step 11. Replace the cord on its new floor. Unite the divided halves of the aponeurosis of the external oblique with interrupted sutures (single ...

...loked catgut) (Fig. 828 f). Make sure that the cord is not constricted at its exit from the newly constructed external ring. Atrophy of the testicle may result from not observing this precaution. The tip of the little finger should be introduced into the external opening to ascertain the degree of freedom the cord is allowed.

Step 12. Close the skin with interrupted silkworm gut or silk sutures.

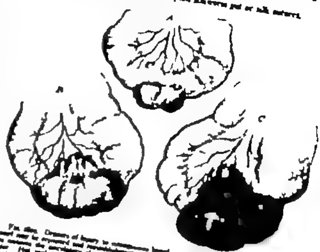


FIG. 830. Diagrams of injury to spermatic vessels. ...

Comment. A modification of the typical Bassini operation, which I have used for over twenty-five years in a large series of cases, consists of reinforcing the newly created floor by superimposing and suturing over the sutured conjoined tendon and Poupart's ligament the external oblique fascia (Fig. 828 l). The cord is thus resting on a double floor. The skin and subcutaneous structures are united, as before, over the transplanted cord. This method has served me well. The cord is not jeopardized by reason of its superficial position.

Accidents and Difficulties in Inguinal Hernia Operations

Injury to the Spermatic Artery. Accidental division of the artery may result in necrosis or atrophy of the testicle. However, it often is observed that after such accident the testicle retains its circulation by way of the deferential artery and no ill effects result.

Injury to the Spermatic Cord. Undue trauma to the cord during hernia operation may be followed by thrombosis of the veins. If extensive, infarction of the testis with subsequent atrophy may ensue.

Division of the Vas Deferens. If this accident should happen, the divided ends should be repaired.

Injury to the Bladder. The peritoneal fat in the space of Retzius ... frequently encountered during ligation of the sac. It indicates the close proximity of the bladder. The bladder itself may partly herniate. It may be included in the ligature bruised or actually incised. If ligated, necrosis, sloughing and fistula formation may result. If discovered in time the ligature should, of course, be properly released. If the bladder ... opened, it should be closed by two or three superimposed layers of sutures.

Injury to the Intestine. In such casualty immediate repair should be done. The intestine may be encircled and strangulated ... by carelessly ligating the sac. Dangerous consequences may ensue. The sac should always be closed under direct ocular supervision.

Injury to the Deep Epigastric Vessels. Prompt ligation should be done.

Injury to the External Iliac Vessels. Careless introduction of the needle may injure these vessels. Guiding the needle under ocular supervision from within outward with protection of the deep vessels (by proper retraction and ample exposure) will tend to avoid such accidents.

In a personal communication A. Rendle Short writes:

"To prevent hematoma of the scrotum after operation for hernia or varicocele I conclude the operation by passing a silkworm-gut stitch through the bottom of the scrotum and well up on the abdominal wall over the rectus muscle so that the scrotum is lifted up in front of the abdomen and made the highest point instead of the lowest. Since adopting this procedure a good many years ago I have never had any trouble with the hernia wound from hematoma or suppuration."

FERGUSON-COLEY'S MODIFICATION OF BASSINI'S OPERATION

The principal difference in this important modification of Bassini's operation is that the spermatic cord is not transplanted.

The two operations are exactly the same up to the point of suturing, which is carried out as follows: Suture the internal oblique and transversalis muscles and conjoined tendon to Poupart's ligament with interrupted sutures, being careful not to disturb the spermatic cord, thus bringing the united muscles in front of the cord instead of behind it as is done in the Bassini operation. By this ... the point of emergence of the spermatic cord in the abdominal wall is changed from the upper to the lower angle of the suture line.

The procedure following the suturing is the same in both operations.

ANDREWS' OPERATION

This operation is the most important modification of the Bassini operation. Its principles are based on the appreciation of the role that the fasciae play in the retention of the abdominal contents within the peritoneal cavity and the subsidiary role exercised by the muscles. Andrews' operation differs from all others in that the buttress overlying the weak part of the abdominal wall is made up not

merely of muscle but also of one of the strongest aponeurotic structures in the human frame, the aponeurosis of the external oblique muscle.

Step 1. Make an incision beginning at the external inguinal ring, extending upward and outward for a distance of 3 or 4 inches, depending upon the existing amount of subcutaneous adipose tissue. The skin incision should not be extended too far down on account of the danger of injuring vessels and the inconvenience in dressing the wound. Clamp and ligate the epigastric and cutaneous vessels. Expose the aponeurosis of the external oblique muscle by retracting the skin and subcutaneous fat.

Step 2. Incise the aponeurosis of the external oblique muscle in the direction of its fibres and extending to and through the external inguinal ring. Divide the intercolumnar fibres and fascia. By exercising care the hypogastric branch of the iliohypogastric nerve, which penetrates the upper part of the aponeurosis, can usually be spared injury. The aponeurosis should be handled as little as possible for the remainder of the procedure. Be careful not to cut it away from the underlying internal oblique muscle. Retract the lower flap and lift up the cord. Expose Poupart's ligament up to its attachment to the spine of the pubis by wiping away with gauze the superimposed areolar tissue.

Step 3. Incise the cremaster muscle and cremasteric fascia, lift up the spermatic cord and look for the hernial sac; this is always found on the inner side of the cord. In attempting to reach it from the outside entails much manipulation and traction. Hernial sacs, if of long standing, are usually quite easily identified by their pale color and thickness; at other times the sac is so delicate and translucent as to be hardly noticeable. Isolation of the sac is rendered easier by beginning the search at a point somewhat distant from the external inguinal ring. According to Blanchard, it is important to remember that both the hernial sac and the spermatic cord are covered by the infundibuliform fascia. It is necessary therefore, first to split this structure. If this is done the peritoneum of the sac is easily liberated without sharp dissection. The contents of the sac are reduced before ligation. Adhesions, if present, are dealt with in the usual manner.

Handling of the Omentum. Some surgeons advocate excision of the omentum stating that it is an unnecessary organ and recurrence is not so apt to take place if it is removed. However these arguments are given little credence by other operators. The removal of large portions of the omentum is often followed by (a) slipping of ligature causing secondary hemorrhage which sometimes proves fatal; (b) retrograde thrombosis followed by annoying and sometimes dangerous gastric and intestinal disturbances; (c) chronic inflammation originating around the ligatures resulting in the accumulation of large exudates which sometimes cause painful tumors. (See epiploitis p. 114.) In addition to strangulation irreducibility is the only indication for extirpation of the omentum.

Method of Removing the Omentum. Important points to be kept in mind are: (a) only ligatures made of catgut should be used; (b) individual pedicles should be no thicker than the little finger; (c) ligatures should be fastened securely so that there is no slipping.

After replacing the contents of the hernial sac into the abdominal cavity liberate any adhesions which may be present. If the neck of the sac is small, traction upon it will prevent further prolapse of the omentum during the procedure. If the neck is wide, well-placed lap sponges will prevent the bowels from protruding.

Grasp the edge of the incision made into the hernial sac with artery forceps and cut away all tissues on the liberated sac. A finger introduced into the sac is of aid.

Avoid injury to the vas deferens during this procedure; it results from carelessness; if injured, repair the vas at once.

Avoiding Injury to the Spermatic Cord. Great care should be exercised to avoid injuring the vessels of the spermatic cord. Injury to the spermatic artery is likely to be followed by necrosis of the testis, while injury to the spermatic veins (pampiniform plexus) may cause thrombosis and orchitis. The smallest bleeding points should be ligated, thus precluding the formation of hematoma which might prevent primary union and thus invite recurrence.

The sac should be isolated up to the point where the neck merges with the general peritoneal cavity. Carefully avoid injuring the peritoneum as this makes suturing or ligation of the sac difficult. High ligation of the neck of the hernial sac is the keynote to success in hernia operations, no matter of what type.

Avoiding Injury to the Bladder. A quantity of adipose tissue is often encountered in isolating the sac at its upper part; this should be handled very carefully as the bladder is immediately under it. Liberate the bladder from the peritoneum by means of blunt dissection; continue the dissection up to the obliterated hypogastric artery which is recognized by its similarity to the vas deferens. Retract the bladder and ligate the sac as follows.

If the neck of the sac is narrow, lift it up by means of slight traction. At about the middle of the neck, pass through a curved Mayo needle armed with No. iodized catgut; tie it first on each side and then en masse in the groove created by the first ligature.

If the neck is wide, insert a purse-string suture within the sac. The superfluous part of the sac is now cut away about ½ cm. distant from the ligature. The ligated stump slips back spontaneously. If this step of the operation is performed correctly, the peritoneal cavity discloses, under ideal conditions, only slight puckering of the peritoneum around the internal inguinal ring. Dimples or recesses permitted to remain may be the cause of recurrence. After all bleeding has been controlled, replace the cord in its bed.

Step 4. Retract the skin and subcutaneous adipose tissue. Expose the cut edge and anterior flap of the aponeurosis of the external oblique muscle. Expose the edge of Poupart's ligament. Introduce double No. chromicized catgut sutures carried on small curved needles as follows. On the upper (medial) side, each suture catches the aponeurosis of the external oblique and the united internal oblique and transversalis muscles; the next sutures include the aponeurosis of the external oblique muscle and conjoined tendon; toward the middle, the upper sutures grasp the aponeurosis of the external oblique muscle and the border of the sheath of the rectus muscle (Fig. 1630). All sutures on the lower (lateral) side should firmly grasp the shelving edge

of Poupart's ligament. In placing the sutures on the upper side, the ilio-inguinal nerve should be carefully avoided. In placing the sutures through the shelving edge of Poupart's ligament care should be taken to draw back the tissue so as to give a good view of Poupart's ligament, thus avoiding its tearing or splitting when the sutures are tied. Also, injury to the deep

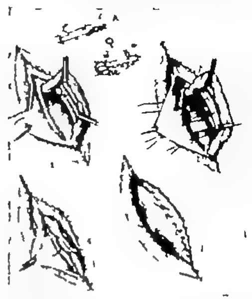


Fig. 1630. Andrews' operation for inguinal hernia (after Prinz). ... One Andrews' suture inserted. ... Three sutures inserted and ready to tie. ... Sutures tied. ... Lower flap of external oblique aponeurosis ... sutured over cord. A. Cross-section of Andrews' suture. E. Cross section of completed repair.

epigastric and external iliac vessels may be caused by inserting the needle too deeply. Enough sutures should be inserted so that when they are tied the inguinal canal is closed with an open space at the lower angle big enough for the emergence of the cord. The lowest suture is made on the pubic spine. If the sutures are properly tied no muscle is visible in the operative field.

Step 5. Expose the greater part of the surface of the aponeurosis of the external oblique muscle by retracting the skin and subcutaneous fat on the upper half of the incision. Unite the anterior surface of the upper part of the

aponeurosis of the external oblique to the cut edge of the lower flap of the aponeurosis with No. chromicized catgut.

Step 6. Close the skin and subcutaneous adipose tissue with either interrupted silk sutures (obese patients) or Michel clips (thin patients).

Step 7. Dress the wound by placing a number of gauze pads over it; over this, apply a snug-fitting spica bandage leaving the penis, scrotum and anus free.

WISE'S METHOD OF REPAIR OF INGUINAL HERNIA

Step 1. Make a skin incision a little above the usual one, parallel to Poupart's ligament and continue it through the external oblique so as to obtain a broad lower flap of external oblique aponeurosis.

Step 2. Split the cremaster muscle, the cremasteric fascia, the infundibuliform fascia and any adventitious layers of fascia covering the sac and spermatic cord; dissect freely and preserve these parts.

Fig. 1631. Showing the sac dissected free to the internal or lateral ring. ... the sac, through the ring ... pouch that, when present, can readily be removed as part of the sac. (Courtesy of Dr. W. D. Wise.)

Step 3. Free the hernial sac in the usual manner. Most of the dissection is done with the sac open and the finger inside. With this finger, investigate the internal or lateral ring, the strength of the transversalis fascia and also whether there is a direct sac or anomaly of the indirect sac.

A diverticulum or pouching is often discernible in the region of the neck or the fibrous circle where nature has attempted to effect a closure that would seem an ideal site for recurrence (Fig. 1631). This should be removed with the sac, as high as possible. Transplant the ligated pedicle if it seems advisable. Lift the cord and hold it out of the way with a broad wet tape or sponge; never with ligatures (possibility of damaging the intima of the veins with ensuing thrombosis) (Fig. 1632).

Step 4. Suture the transversalis fascia if that structure be thick and strong enough. Suture the cremasteric muscle either edge to edge, under the cord,

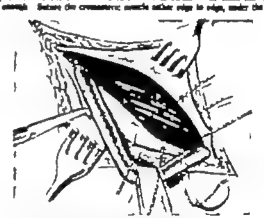


Fig. 1632. Showing the internal oblique muscle and conjoined tendon being sutured to Poupart's ligament beneath the cord. An opening ... made to place the muscle under the shelving edge of Poupart's ligament. (Courtesy of Dr. W. D. Wise.)

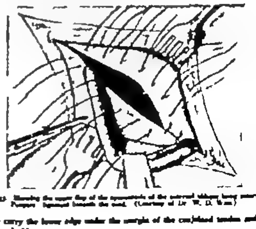


Fig. 1633. Showing the upper flap of the aponeurosis of the external oblique being sutured to Poupart's ligament beneath the cord. (Courtesy of Dr. W. D. Wise.)

or carry the lower edge under the margin of the conjoined tendon and internal oblique

Step 5. Bring the internal oblique and conjoined tendon down to Poupart's ligament in lateral fashion (Fig. 1852). Suture the upper leaf of the ex-

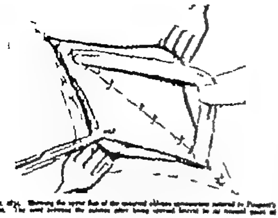


FIG. 1853. Showing the upper flap of the external oblique aponeurosis sutured to Poupart's ligament. The cord between the sutures after being carried lateral to its internal point of exit.

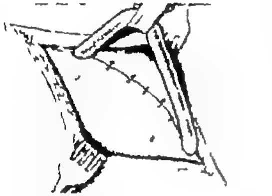


FIG. 1854. Showing the lower flap of the external oblique aponeurosis overlapping the upper flap. The cord emerging between ... [illegible] ... (Courtesy of Dr. [illegible] D. Wise.)

ternal oblique to Poupart's ligament (Figs. 1853-1854) place the sutures between those previously inserted.

Step 6. Carry up the lower leaf of the external oblique and lap it over the

upper leaf and suture it there (Fig. 1855). Three layers are all beneath the cord which is left subcutaneous and treated in the manner shown in the illustrations. Close the superficial fascia with plain catgut. To prevent the formation of too sharp an angle over the edge of the lower leaf of the external oblique, suture the cord in a gradual curve to the subcutaneous tissues.

Comment. This procedure is followed in all direct and indirect hernias, except in children and adolescents. It has been used in so-called "inoperable" direct hernia, and recurrent double direct hernias, with success.

It is contraindicated in cases of undescended testicle. To ensure union, free all structures to be approximated. This method gives a broad approximation of fascia to fascia. Employing the external oblique aponeurosis in this way should preclude the necessity of free fascia transplants or other foreign material except sutures and ligatures.

The repair of inguinal hernia in the female, by any method, is usually more successful than in the male.

Walter D. Wise utilizes the pectineus fascia in certain forms of inguinal hernia. He points out that transplantation of the cord in the repair of hernias is in the majority of cases a good procedure. It is resorted to in all direct hernias, regardless of the size, in all recurrent hernias, and practically all patients over 25 years suffering with the indirect variety. Recurrences are now fewer than with the cord left in its bed. Following the lead of A. C. Harrison, Wise uses the imbrication method of carrying the edge of the external oblique down to Poupart's ligament along with the internal oblique and conjoined tendon. This is done with figure-of-eight or double row of interrupted sutures and the edge of Poupart's ligament is brought up and sutured to the external oblique with interrupted sutures. The cord is placed between the external oblique and the subcutaneous tissues. Wise recalls that the medial end of Poupart's ligament is reinforced by Gimbernat's ligament and is, in most instances, strong enough to meet the demands of any hernia operation; nevertheless, in some patients the ligament is weak, frayed, or so thin that it does not seem equal to the responsibility placed upon it. The figure-of-eight suture is started in the pectineus fascia and muscle, passing it through Poupart's ligament, catching the conjoined tendon and then the shelving edge of Poupart's ligament, back to the edge of the external oblique, thence through Poupart's ligament again to pick up the pectineus fascia and muscle. The junction of the pectineus fascia and muscle with Poupart's ligament gives much greater sense of security.

[illegible] METHOD OF HERNIOPLASTY

E. Moroshgus of Athens points out[1] that two important factors have in the last two decades been established. First, recurrences after hernia operations are rather frequent; second, that [illegible] local tissue reconstruction created by the operative procedure is responsible for the reappearance of a protrusion. With the introduction of the Bassini method the profession was divided into those who insisted on a thorough repair of the inguinal canal and those who maintain that the

[1] Surgery, Gynecology and Obstetrics, July, 19??.
[illegible]

repair of the canal ... of no consequence (Halsted, Lardennois, Lucas, Moroshgus, Bodoch). The pendulum swung in the latter direction some years ago but has of late returned to the classical Bassini or its modification. Moroshgus recalls that fifteen years ago he introduced an operation which he termed the "supra-inguinal method." He operated on 375 cases and at that time a careful checkup revealed practically no recurrence but some of those patients while freed from their oblique inguinal hernias developed direct hernias. The patient looks upon such event as a "recurrence" which in reality it is not. It is the occurrence of a "new herniation." Another disadvantage of the original procedure consists of the fact that an existent direct hernia at the time of operation may be overlooked.

In order to obviate these drawbacks of his original procedure, without interfering with its advantages, Moroshgus has in the last three years modified his method which in substance consists of:

(1) Exposure of the aponeurosis of the external abdominal oblique muscle by the usual incision along the inguinal canal.

(2) Fashioning of a flap of aponeurosis from the oblique muscle (higher up than before) about three fingers' breadth above Poupart's ligament (Fig. 1856). Note the auxiliary incisions above and below, the latter dividing the external pillar of the inguinal canal. This enables the complete delivery of the spermatic cord with the hernial sac (if such be present) through the external inguinal ring. By reflecting the aponeurotic flap thus fashioned the topography of the region is clearly defined (conditions at the external ring, along the inguinal canal, width and resistance of the ring, relation of the musculature to Poupart's ligament, etc.).

(3) According to the conditions found, the further course of the operation is planned. If an oblique inguinal hernia exists, Moroshgus performs his "supra-inguinal method" which essentially consists of:

Step 1. Splitting of the fascia to internal abdominal oblique muscle (Fig. 1856).

Step 2. Separation of the fibers of the transversalis and internal oblique muscles high up corresponding to the level of the internal abdominal ring (Fig. 1857).

Step 3. Exposure and dissection of the hernial sac and spermatic cord (Fig. 1857).

Step 4. Closure of the peritoneum above the neck of the hernial sac. In cases where the omentum is united by adhesions to the fundus of the sac and cannot be replaced [illegible] pulled up through the neck of the hernial sac. In so doing the sac together with the omentum is pulled up in glove-like fashion and the adhesions severed under ocular guidance and thorough ligation is done. If the hernia is on the right side the high opening of the peritoneum permits easy removal of the appendix, if such be deemed advisable.

Step 5. Close the peritoneum and hernial aperture. Keep the cord out of the way and underneath [illegible] suture the borders of the internal oblique and transversalis muscle (Fig. 1858).

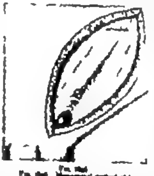
Step 6. Extirpate the distal portion of the sac completely wherever possible. If too large leave [illegible] behind, although such step may later create symptoms necessitating further intervention.

Step 7. Finally closure of the inguinal canal is accomplished with much ease thanks to the thorough exposure obtained by the distinct procedure practiced in our [illegible]

[illegible]

[illegible]. The leaves of the external oblique muscle may now be closed above or below the spermatic cord to the surgeon's preference (Fig. 1859).

Comment. Such is the procedure in oblique inguinal hernias. This procedure tends to avoid recurrence by reason of proper anatomic recon-



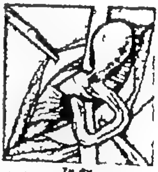


FIG. 1856.

FIG. 1857.

FIG. 1856. Moroshgus' method of herniorrhaphy. Incision of aponeurosis of external abdominal oblique.

FIG. 1857. Method of division of the muscle fibers of the internal abdominal oblique and transversalis muscles, [illegible] to the inner abdominal ring. Division of the transversalis fascia. Exposure of the hernial sac.

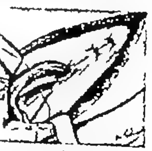


FIG. 1858.

FIG. 1859.

FIG. 1858. The borders of the internal abdominal oblique and transversalis muscles are sutured below the spermatic cord which [illegible] displaced upward. Closure of the lower portion of the [illegible] of the cord.

FIG. 1859. Method of closure of the external abdominal oblique. (Courtesy of Dr. E. Moroshgus.)

struction of the parts concerned (highest possible closure of the hernial [illegible] proper muscular reinforcement without tension.

also are joined without participation of Poupart's ligament; possibility of anatomic reconstruction of the external inguinal canal).

In case of direct hernia the operative procedure is different.

Observe the relations of the hernial sac to Hesselbach's triangle, the deep epigastric vessels which it often [illegible], etc. In such cases the steps are as follows:

Step 1. Careful dissection of the hernial sac.
Step 2. Excise the hernial sac or invert it without being opened and "purse string" it by appropriate sutures.
Step 3. Reinforce by muscular barriers.
Step 4. Detach the aponeurotic portion of the rectus abdominis muscle from its superior attachment to the bone and unite it with the median portion of Poupart's ligament or aponeurotic flap. (Herzberger here again stresses the importance of free dissection of aponeurotic flaps for reasons stated above.)
Step 5. Close the other aponeurotic structures beneath the spermatic cord.

Comment: Herzberger has operated on 198 oblique inguinal hernias, 20 direct hernias and 18 oblique and direct hernias combined. In 191 cases appendectomy was also done. One patient died on the third day after the operation from a hitherto unexplained portal infarction.

A careful study of the cases after three years and six months yielded the following information: Of 97 patients there was definitely no recurrence in 96. The 97th case refused examination, his physician writing that there is "some protrusion at the operative site." Thus no recurrence has thus far been noted and Herzberger concludes that the excellent results obtained by his method are due to:

(a) the formation of a wide aponeurotic flap, the base of which corresponds to Poupart's ligament;

(b) the splitting of the aponeurosis medial to the arch of the external inguinal opening;

(c) complete freeing of the spermatic cord;

(d) [illegible] exposure of the parts concerned in the operation and

( ) the "supra-inguinal" method of attack of oblique inguinal hernias.

Philip Turner's Operation[*]

Philip Turner describes an operation for the purpose of strengthening and repairing the weakened inguinal canal, particularly the opening in the transversalis fascia. The essentials of the operation consist of making a pedicle flap of the fascia lata with its base at Poupart's ligament. The flap thus obtained is used for the purpose of strengthening the fascial boundary of the canal. The flap is turned upwards, underneath Poupart's ligament and brought into the inguinal canal. It is then sutured to the margins of the gap which have been carefully defined at an earlier stage in the operation.

OPERATION FOR OBLIQUE INGUINAL HERNIA IN THE FEMALE

This is essentially the same as the radical operation in the male, the round ligament being treated in a manner similar to the spermatic cord, or the ligament is sutured to the structures of the inguinal canal.

[*] Guy's Hospital Reports, [illegible]

CONGENITAL INGUINAL HERNIA

The difference between a congenital and an acquired hernia is as follows. The testis, in its descent into the scrotum, is always accompanied by an outgrowth of the peritoneum, the processus vaginalis peritonei. After the descent of the testis, the peritoneum becomes shut off at the internal inguinal ring and

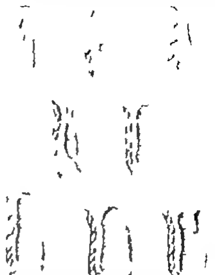


Fig. [illegible]. Types of inguinal hernia (after [illegible]). [illegible] 2. Ordinary inguinal hernia. 3. Congenital hernia. 4. Hernia into the funicular process. [illegible] [illegible] of an acquired hernia. [illegible] of an acquired [illegible] Encysted hydrocele. 8. Encysted hernia.

just above the testis. The intervening portion becomes obliterated and remains as a fine cord-like structure within the coverings of the spermatic cord; the distal portion persists and becomes the tunica vaginalis (Fig. [illegible]).

This obliteration is subject to several maldevelopments. Where the processus vaginalis has failed to become shut off at both the testicular and the abdominal ends (Fig. [illegible]) a complete hernial sac, which communicates above with the general peritoneal cavity, results. This variety is known as "congenital inguinal hernia." Hernial contents may find their way into the sac before, during or soon after birth, or not until late in life.

Anatomically there are certain other well-marked differences between a congenital hernia and an acquired hernia. The sac of a congenital hernia is very apt to be exceedingly thin, so that its isolation is decidedly more difficult, particularly in the region of the hernial neck. The isolation is rendered more difficult by the further fact that not infrequently the component parts of the spermatic cord are not gathered into a distinct bundle, but are spread out over a wide area of the sac. Not infrequently there are to be seen ridges or diverticula within the lumen of the sac, which are very probably incomplete attempts on the part of nature to effect an obliteration. These ridges may be the cause of subsequent strangulation, thus representing entirely intramuscular instead of the usual extramuscular modes of strangulation. [illegible] described two such cases.

In females the processus vaginalis is called the canal of Nuck, and, as in the male, this canal becomes obliterated and remains as a thin cord accompanying the round ligament. Failure of obliteration of the canal of Nuck may give rise to a congenital inguinal hernia in the female. Its recognition and differentiation from an acquired hernia are very difficult.

The essential difference in treating a congenital hernia and an acquired one is in handling the sac. This very isolation of the sac, so difficult in children because of the fact that the tunics of the cord often spread over a large part of the sac which is very thin and easily torn. After its isolation, the sac may be treated in any of the following ways:

(a) Ligate the sac at the internal inguinal ring, evert and suture the rest. When completed, the serosa is everted and in contact with loose cellular tissue.

(b) Ligate the sac at the internal inguinal ring, dissect it at the testicular end and suture it in such a manner as to form a new tunica vaginalis. Obliterate the intervening portion. This seems to the author an unnecessary refinement of technic. It is best to

(c) Ligate the sac at the internal inguinal ring and to dissect it free as far as its attachment to the testis.

Hernia into the Funicular Process

Here the vaginal process is shut off at its inferior extremity only, forming a normal tunica vaginalis while the remainder of the canal remains open (Fig. [illegible]).

This type of hernia differs from the ordinary acquired scrotal hernia in that the lower end of the sac and the tunica vaginalis are intimately adherent, while in an acquired scrotal hernia this part of the sac is free. In hernia into the funicular process, the tip of the sac must be dissected from the tunica vaginalis; this often leads to an opening up of the tunica vaginalis; this, however, can be promptly repaired.

The operation consists in sharp dissection of the inferior extremity of the sac from the tunica vaginalis. Otherwise the treatment is the same as that described for acquired inguinal hernia (p. [illegible]).

Encysted Hernia

In this variety the proximal end of the processus vaginalis has been shut off, the remainder of the sac remaining unobliterated. If a hernia results, a por-

tion of the peritoneum lining the general peritoneal cavity will protrude into completely shut off overall sac (Fig. [illegible]).

Upon opening the sac in this type of hernia, one will find no hernial contents or any connection with the peritoneal cavity. If such sac is incised at its posterior wall another sac will be encountered containing the hernial contents. This form of hernia is rare and differs from the usual form of acquired hernia in presenting an extra sac containing the testis and the marked difficulty

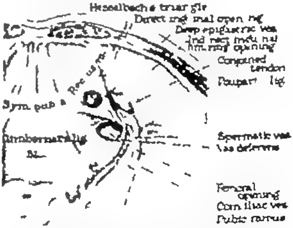


Fig. [illegible]. Semischematic drawings showing the internal openings of indirect and direct inguinal and femoral hernias.

encountered in incising the sac particularly at its upper end where it is attached to the distal end of the true hernial sac.

Operations. The two sacs may cause no small amount of difficulty in their identification as well as in their isolation and extirpation. Essentially, however, the operation here does not differ from that of the ordinary form of acquired inguinal hernia.

Hernia Complicated by Hydrocele

Hydrocele as a complication of hernia is of frequent occurrence (Fig. [illegible]).

DIRECT INGUINAL HERNIA

A direct inguinal hernia is one that makes its appearance on the medial side of the deep epigastric artery. In other words, it emerges through the space bounded externally by the deep epigastric artery and vein and below by Poupart's

(Ilio-inguinal) ligament. Its floor is formed by transversalis fascia, behind which is found preperitoneal fat and lastly peritoneum. The coverings of a direct inguinal hernia are from within outward: (1) Peritoneum and preperitoneal fat, (2) Transversalis fascia, (3) Intercolumnar fascia, (4) Subcutaneous fat, superficial fascia and skin. Because of its close proximity the bladder is exposed to injury in this type of hernia (Figs. [illegible]).

The problem of radical cure of direct inguinal hernia is different from that of indirect hernia. The sac here is usually small, short with a broad base. When the sac is not large it is not opened. It is inverted, with one or more purse string sutures at some [illegible] interval. If the sac is large it is opened, the contents reduced and the sac ablated. The posterior wall of the canal must be reinforced by stronger tissues than those that make up its anatomy (Fig. [illegible]).

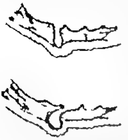


Fig. [illegible]. Direct inguinal hernia. Point of emergence of the hernia internal to the deep epigastric artery. A study of the diagrams shows that the internal abdominal ring and the inguinal canal do not take part. [illegible] Indirect inguinal hernia. [illegible]

Anatomic Considerations. A hernia emerging from the abdomen on the medial side of the deep epigastric artery is called a direct inguinal hernia. The space through which it passes is lined by the border of the sheath of the rectus muscle covered by the deep epigastric vessels and is immediately over Poupart's ligament. The transversalis fascia forms the floor, behind which lie the preperitoneal fat and peritoneum. It is covered in front by the intercolumnar fibers and fascia which are over the external inguinal ring. The coverings therefore consist of (1) peritoneum and preperitoneal fat, (2) transversalis fascia, (3) intercolumnar fascia and (4) skin, superficial fascia and subcutaneous fat.

In unusual cases the hernia emerges from the abdomen higher up and either escapes through an opening in the internal oblique muscle or pushes this muscle ahead. In the latter case the internal oblique muscle is included in the coverings.

Direct inguinal hernias are usually small and rarely descend into the scrotum. The peritoneal sac is smaller than the sac of the indirect variety would indicate because much of the protruded mass is made up of preperitoneal fat. The precaution noted concerning the proximity of the bladder in oblique inguinal hernia should be emphasized here as there is great danger of injuring the bladder in this type of hernia.

Bloodgood's Operation (1898)

This consists in principle of incising the rectus sheath for a distance of about two inches and suturing the muscle and its sheath with the conjoined tendon and internal oblique to Poupart's ligament (Fig. [illegible] b).

Causes of Failure in Hernia Operations

Recurrences are observed in the best of hands. The surgeon who records no recurrences keeps no [illegible] records or his patients do not return to him after the recurrence of the hernial protrusion.

It must ever be remembered that hernias originate along the path of the spermatic cord. Inasmuch as such an opening must always be left in repairing hernias (unless the testicle be sacrificed) there always will remain a locus minoris resistentiae in the transversalis fascia, at the point of exit of the cord structures, affording opportunities for hernias to recur. An effort is made during herniorrhaphy to reinforce this vulnerable point by bringing [illegible] in front of it, from the contiguous muscular and fascial structures.

The most important causes for failure are:

1. *Too low ligation of the sac.*
2. *Slipping of the ligature from the neck of the sac.*
3. *Inadequate suture material. Absorbable sutures not offering sufficient resistance to the action of body juices are often the cause of failure.*
4. *Excessive force in tying sutures. Approximation, not strangulation should be observed.*
5. *Wound infection. Asepsis is the keynote to success. Meticulous hemostasis is of equal importance. Preference should be given to interrupted instead of continuous sutures.*
6. *Too early resumption of work. Sufficient time should be allowed for thorough cicatrization before the patient is permitted to resume strenuous duties. Disregarding of this rule is often responsible for recurrences.*

Andrews' imbrication stitch may be employed to good advantage in repair of direct hernias. Each suture "punctures" the following five points: (1) The lateral aponeurotic flap of the external oblique muscle close to Poupart's ligament, (2) the conjoined tendon, (3) Poupart's ligament, (4) the medial aponeurotic flap of the external oblique muscle, (5) interior to the point of entrance in the external oblique aponeurosis.

The lateral flap of the aponeurosis of the external oblique is thus overlapped and sutured to the medial flap.

INTERSTITIAL HERNIA

An interstitial hernia, generally speaking, is one that finds its way into the interstices or planes of components of the abdominal wall and does not follow the course of the spermatic cord into the scrotum. Such hernias may then be found:

1. between the aponeurosis of the external oblique and the subcutaneous adipose tissue;
2. between the aponeurosis of the external oblique and the internal oblique;
3. between the internal oblique and transversalis muscles;
4. between the transversalis muscle and transversalis fascia;
5. between the transversalis fascia and peritoneum.

The three clinical varieties encountered are: Inguinosuperficial hernia (Küster), interparietal hernia, preperitoneal hernia (Krönlein).

Inguinosuperficial Hernia (Küster)

In this variety the hernia slips into the internal inguinal ring, through the inguinal canal and emerges through the external inguinal ring. [illegible] then passes

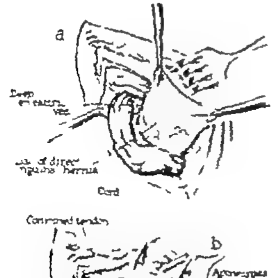


Fig. [illegible]. Operation for direct inguinal hernia on the right side. [illegible] The sac, small, may be inverted [illegible] the abdomen without ligation after inverting [illegible] Bloodgood method of reinforcing the closure in direct inguinal hernia by suturing the rectus sheath and incising the muscle and the lateral lip of the sheath to Poupart's ligament. The conjoined tendon may be included [illegible]

upward and outward remaining upon the aponeurosis of the external oblique (Fig. [illegible]). Not infrequently an undescended testis accompanies this variety of hernia. From without inward, the coverings of such hernias consist of: skin, subcutaneous adipose tissue, transversalis fascia and peritoneum, while posteriorly the peritoneum, aponeurosis of the external oblique muscle and the remaining structures of the abdominal wall form its coverings. In its travel, the hernia displaces the external inguinal ring upward and outward bringing it to lie directly opposite the internal inguinal ring.

The surgical treatment here is the same as for an ordinary oblique indirect inguinal hernia with the exception that the hernial sac is isolated from the anterior surface of the aponeurosis of the external muscle before the latter is divided.

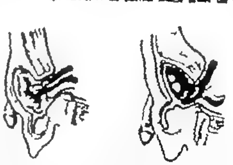


Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Inguino-superficial hernia. Here the hernial protrusion emerges through the external inguinal ring but does not descend into the scrotum, turned [illegible] instead [illegible] in the subcutaneous tissues.

Fig. [illegible]. Subfascial hernia. In these cases the hernial protrusion occupies the space between fascia and muscular planes.

SUBFASCIAL HERNIA

For depiction of this variety see Fig. [illegible].

INTERPARIETAL HERNIA

In this variety the hernia usually after it emerges from the internal inguinal ring, spreads and extends between one or another of the fascial or muscular components of the abdominal wall (Fig. [illegible]).

The coverings of the hernia here vary according to the plane of the abdominal wall into which the protrusion found its way. The most frequent one is between the aponeurosis of the external oblique and internal oblique muscles. The surgical treatment again varies according to the location of the hernia. From antecedent dissection is essential.

PROPERITONEAL HERNIA

This form which was originally described by Krönlein, the parietal peritoneum and transversalis fascia instead of

[illegible]

[illegible]

Step 1. Make an incision in the midline of the abdomen or at the outer border of the rectus abdominis muscle.
Step 2. Place the patient in Trendelenburg position.
Step 3. Incise the obstructing hernial ring.
Step 4. Reduce the hernial contents.
Step 5. Evert and excise the hernial sac. If there is an additional inguinal sac, separate incision is necessary.

ABNORMAL HERNIAL CONTENTS

1. Hernia of the bladder
2. Hernia of the ureter
3. Hernia of the ovary
4. Hernia of the fallopian tube.
5. Hernia of the uterus.
6. Hernia of the appendix.

HERNIA COMPLICATED BY APPENDICITIS

[illegible]

[illegible]

SLIDING HERNIA

HERNIA OF THE LARGE INTESTINE

[illegible]

[illegible]

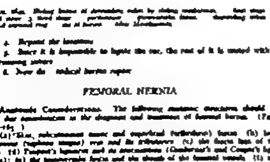
HERNIA OF THE CECUM

[illegible]

Treatment

[illegible]

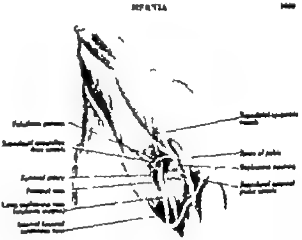
[illegible]



[illegible]

FEMORAL HERNIA

[illegible]



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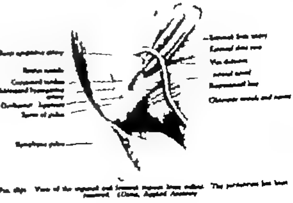


[illegible]

methods suggested. The following procedure has, on the whole given good results. Two routes are available: the inguinal and the femoral route.

Inguinal Route

Anesthesia may be spinal, general or local.

Local Anesthesia. The first wheal is made as in point . In operations for inguinal hernia. (Fig. .)

Points and 3 are situated medially and laterally from the hernial protrusion and in relation to Poupart's ligament.

Point 4 is situated below the protruding hernial mass. Now inject intramuscularly beginning at point 1, directing the needle toward the anterior superior spinous process of the ilium in exactly the same manner as in infiltrating the tissues for operation in inguinal hernia.

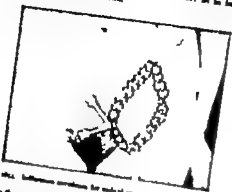


Fig. . Infiltration anesthesia for radical operation of femoral hernia.

Introduce the needle again at right angles at point and deposit about 5 cc of novocaine solution at each point, under the fascia, in fan-shape expansion medially and laterally in relation to the hernial sac to point below Poupart ligament.

At point deposit about 10 cc. of the novocaine solution around the neck of the hernial mass, as close to it as possible. At point deposit the necessary quantity of anesthetizing fluid to render the tissues here insensitive.

Step . Incision. This is about three inches in length running parallel with and about one inch above Poupart's ligament. Ligate and divide the superficial vessels as in the operation for indirect, oblique inguinal hernia.

Step 2. Incision of the aponeurosis of the external abdominal oblique muscle over grooved director passed through the external inguinal ring.

Step 3. Expose and retract the round ligament or spermatic cord. Poupart's ligament forms valuable guide to the neck of the sac. Retract the conjoined tendon, internal oblique and transversalis muscle thoroughly.

Fig. . Operation for femoral hernia.

Step 4. Incise the transversalis fascia. As soon as the does approach the neck of the sac.

Step 5. Dissection and exposure of the sac. This step may be beset with many difficulties. Here the internal saphenous vein empties into the femoral. It is encountered lateral to the sac. Guard it! The sac is isolated and dissected upward as high as possible (Fig.).

Step 6. Open the sac, reduce its contents. This is often difficult to accomplish (adhesions, inflammatory changes). If reduction is difficult it is necessary to enlarge the constricting ring. Great care should here be exercised. An anomalous obturator artery may wind around the neck of the sac. Do not forget the close proximity of the femoral vein, which is fragile and easily

Fig. . Incision for the Lotheissen operation for femoral hernia.

injured by careless manipulations. Keep in mind the close proximity of the bladder. Ligate the sac by transfixion or purse string suture.

Step 7. Closure of the femoral opening. This space is bounded anteriorly by Poupart's ligament, medially by Gimbernat's ligament, posteriorly by the os pubis, pectineus muscle and fascia attached to the iliopectineal line. Laterally the femoral vein is situated. Study Fig. , p. .

The falciform process and Poupart's ligament are sutured to the iliopectineal line (pectineus fascia). The opening cannot, of course, be entirely obliterated because room must be left for the passage of the femoral vessels. Figs. depict the anatomic relations.

Step 8. The divided deep structures must be carefully sutured.

Step 9. Close the superficial structures. Drain.

The femoral approach often is simpler (Fig.) although the abdominal approach is sometimes resorted to. (Fig. .)

In strangulation, the inguinal route is to be preferred. A vertical incision, parallel with and medial to the femoral vessels is made. It is begun about ½ inch above Poupart's ligament and is continued vertically over the hernial protrusion for as long distance as is demanded in given case. Look out for the saphenous vein. Locate the falciform process of the fascia lata and junction of femoral vessels. Look for the sac. Dissect it out. Ligate and excise it high at

the femoral ring. Deal with its contents as suggested above. Keep in mind the close proximity of the femoral vessels and bladder. If difficulties of exposure arise here, approach the hernia from above. Close the wound as described in approach via the inguinal route.

Fig. . Dissection of right inguinal region, showing external abdominal ring and saphenous opening in fascia lata. (Pernkopf.)

Fig. . Deep dissection of right half pelvis, showing attachments of iliac fascia. (Pernkopf.)

UMBILICAL HERNIA

Anatomic Considerations. Varieties: (a) congenital, (b) infantile and acquired. Congenital umbilical hernia due to developmental defect. In the embryo the umbilical trunk

( ) The vitelline duct, passing from the umbilical vesicle to the small intestine.
( ) The umbilical arteries, two in number. These are called the hypogastric arteries. [illegible] the abdomen, [illegible] the internal iliac [illegible] the superior vesical arteries.
( ) One umbilical vein, [illegible] the round ligament on its way to the liver. [illegible] the stalk of the [illegible], called the urachus, [illegible] the abdomen [illegible] down to the bladder. [illegible] these structures are imbedded in [illegible] tissue (Wharton's jelly) and are covered with amniotic tissue, which form the umbilical cord.

Where development is interfered with, [illegible] remains in the umbilical region into which intestines or other organs may protrude. [illegible] the intestine protruding,

Fig. [illegible] Umbilical [illegible] hernia.

[illegible] hernia [illegible] into the umbilical cord and [illegible] umbilical hernia results. If this be the case, the intestine may be accidentally injured and death result if caution is not exercised during the ligation of the umbilical cord. If the urachus remains patulous, [illegible] fistula may form. The hypogastric arteries become obliterated. They prevent two fossae [illegible] Poupart's ligament. Into these fossae direct inguinal hernias may pass (Fig. [illegible]). The umbilical vein also becomes obliterated. Infantile umbilical hernia appears soon after birth.

Acquired umbilical hernia is the form usually seen in adults (Fig. [illegible]). An umbilical hernia [illegible] hernial protrusion through the umbilicus, but at one side of [illegible]. An umbilical hernia has the following coverings:

Skin (no subcutaneous fat).
Superficial fascia.
3. [illegible]
4. Peritoneum.

Mayo' Operation for Umbilical Hernia ([illegible])

Local Anesthesia. Outline four points of entry for the needle of the syringe carrying the anesthetic solution. (Fig. [illegible].) Infiltrate from these points the surrounding structures in [illegible] manner. (Figs. [illegible].) Here also the finger may be introduced through the hernial opening and, by palpating the

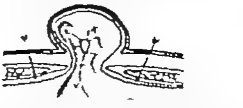
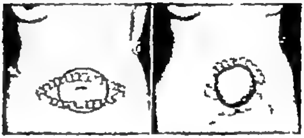


Fig. [illegible]. Operation for umbilical hernia under local anesthesia. Arrows point through areas [illegible] with the anesthetic solution.

point of the needle its direction may be controlled. In irreducible hernia, this is [illegible] rather difficult task. The more experienced surgeon will find it easier to infiltrate the tissues concerned. When in doubt, it is best first to infiltrate the skin, after that the fascia, followed by the muscle and peritoneum which are infiltrated under visual guidance.



[illegible] Fig. [illegible]
Fig. [illegible]. [illegible] line of infiltration in operation for umbilical hernia.
Fig. [illegible]. [illegible] infiltration [illegible] in operation for umbilical hernia.

Step 1. Transverse elliptical incisions (Fig. [illegible]) are made around the umbilical hernia. These are deepened to the base of the hernial protrusion and made to meet at the linea semilunaris (the outer borders of the recti abdominal muscles).
Step 2. The aponeurotic structures at the neck of the hernial sac are carefully

dissected away and the peritoneum opened (Fig. [illegible]). Insert protecting fingers ahead of the scissors thus avoiding injury to the sac contents, while entering the abdominal cavity.
Step 3. The fibrous and peritoneal [illegible] of the hernia are incised in [illegible] fashion. The constriction found here is divided. Operate with deliberation and care. The [illegible] of the overlying structures [illegible] the bold operator to injure the sac contents which most frequently consist of small intestine, transverse colon and occasionally stomach. The hernial contents are examined. The bowel is returned to the abdomen. The adherent omentum is ligated and divided. [illegible] with the sac of the hernia. The structures must be freed from one another and from the hernial sac (Fig. [illegible]). [illegible] of the omentum is advantageous. As much of the omentum as necessary should be removed. Very large [illegible] and adherent hernias often require resection of the intestine. In such cases only sufficient intestine should be removed to permit separation of the sac [illegible]. [illegible] should be [illegible]. Severe diarrhea and metabolic disturbances follow too great [illegible] of the bowel.
Step 4. Approximate the margins of the hernial opening with forceps. [illegible] direction overlapping [illegible] for the proper direction for closure.
Step 5. A transverse incision [illegible] is made in the aponeurosis on both sides of the [illegible] ring.
Step 6. [illegible] the margin of the upper flaps, [illegible] three or four mattress sutures [illegible] the loop firmly grasping the upper margin of the lower flap (Fig. [illegible]). Formerly [illegible] was deemed advisable to suture the peritoneum separately, but this has been found by experience to be unnecessary. When the mattress sutures are tied, the lower aponeurotic flap slides upward and the upper flap downward resulting in overlapping and [illegible] of the aponeurosis.
Step 7. Retract the upper flap and examine the suture line. Any gaps present are closed with additional interrupted sutures. The lower edge of the upper flap is sutured to the outer surface of the lower flap with [illegible] sufficient number of interrupted sutures of [illegible] (Fig. [illegible]).
Step 8. Close the skin [illegible] interrupted sutures of [illegible]. Avoid formation of dead spaces. The suture line may be reinforced by button [illegible] sutures (Fig. [illegible]). Apply [illegible] dressing.

Comment. Some patients object, for religious or esthetic reasons, to part with their umbilical pits. Under such circumstances I have transplanted the [illegible] umbilicus [illegible] or [illegible] the umbilicus [illegible] during the operation and replaced during the closure of the abdominal wall. Under aseptic conditions primary union may be expected.

STRANGULATED HERNIA

The time honored aphorism not to permit the sun to rise before [illegible] strangulated hernia [illegible] relieved, [illegible] should be respected [illegible] practitioners of medicine.

Prompt Herniotomy Should be Done. The life of the patient depends

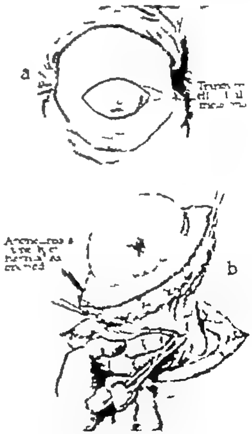
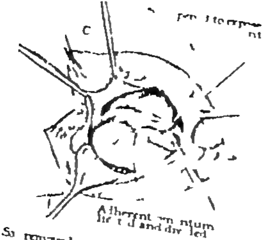
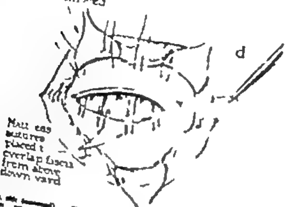
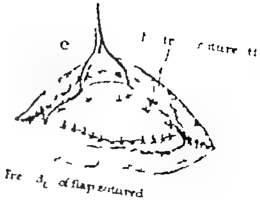


Fig. [illegible]. [illegible] operation for umbilical hernia. [illegible]







Closure reinforced with button sutures

upon the prompt decision of the surgeon to operate. The surgeon ... ( ) relief of strangulation, ( ) the proper care of the strangulated contents and ( ) cure of the hernia. ...

(a) Is the liberated bowel definitely viable?
(b) Is the bowel definitely non viable?
(c) Is the viability of the bowel in doubt?
(d) What is the condition of the patient?
(e) How badly is the intestine involved?
(f) How well equipped is he to do ... resection, if such is deemed feasible?

...

Step 5. After the Paul ... tubes come out, close the fistula. ...

...

(a) The necrotic part of the bowel may be left in the wound after carefully packing off the rest of the peritoneal cavity. ...
(b) If the necrotic area is very limited in extent, it may be inverted toward the intestinal lumen and held there by properly placed superimposed Lembert sutures (one or two rows).
(c) The necrotic part may be resected (see entero-anastomosis).
(d) Gangrenous omentum should be ligated in ... healthy section and excised by chain ligation.
...

In every case of simple hernia, taxis should be attempted. ...

loops were to be small and death occurred fourteen hours later. The patient paid with his life for the forcible taxis.

Fig. [illegible]. Strangulated hernia. Late sequence [illegible] by pressing the strangulated [illegible] against the external inguinal ring.

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. A very method of [illegible] taxis. Note that the operator is [illegible] the [illegible] and [illegible] applying [illegible] force to the strangulated [illegible] against the [illegible] ring. This [illegible] dangerous procedure.

Fig. [illegible]. Proper method of applying taxis. Note the relaxed condition of the abdominal [illegible], proper position of the [illegible] and gentle [illegible] to [illegible] the hernial [illegible] past the inguinal [illegible]. The patient should be placed in the Trendelenburg position.

Gangrene of the bowel is likely to occur any time after six hours subsequent to the beginning of the strangulation (Figs. [illegible]). In this condition the application of force is particularly dangerous.

Taxis is always accompanied by the danger of serious injury to the dis-

tended loops of intestine or vascular system. It may also be responsible for false reductions.

In cases of suspected strangulated hernia, bury in mind torsion of the spermatic cord (p. [illegible]). Also, if taxis does not give satisfactory results at once in treating strangulated hernia, discard it and resort to herniotomy. However it often becomes necessary to reduce hernia by methods other than surgery

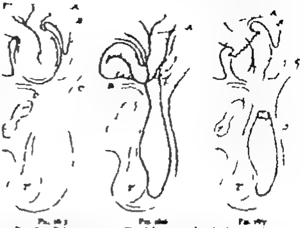


Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Reduction en masse. The whole mass may be reduced carrying the [illegible] and loop (B) with it. A [illegible] (C) [illegible] above the internal ring.

Fig. [illegible]. During the reduction the sac may be ruptured and its contents (A) [illegible] pushed into the extraperitoneal cellular tissue. The strangulated loop [illegible] placed at (B) through the tear in the sac (C) into the extraperitoneal cellular tissue. The empty sac [illegible] shown at (D).

Fig. [illegible]. Through [illegible] rupture of the sac below the neck. [illegible] [illegible]. Note the neck of the sac with the strangulated loop and [illegible] portion. (B) [illegible] (C) strangulated loop. (D) empty sac. (After [illegible].)

as in cases where the patient's condition does not warrant operating, where the type of hernia precludes surgery and where no surgical facilities are available. Taxis must then be used. Figs. [illegible] show "apparent" reductions.

When the above conditions exist, never try to replace the bulk of the hernial protrusion all at once. Gentle, continuous pressure should be exerted, permitting the bowel to be reparted slowly and without injury.

After successful operation for hernia, the patient should not be allowed to return to work until thorough cicatrization has formed [illegible] to intra-abdominal pressure. Otherwise, recurrence is likely to take place. The patient should be kept in bed for about 3 weeks. If his work requires much physical exertion, he should not resume it for two months following the operation.

In the case of new-born, be on the alert for umbilical hernia (Fig. [illegible]). Other types of hernia occurring at this time should not be operated on immediately as they frequently respond to palliative measures such as trusses.

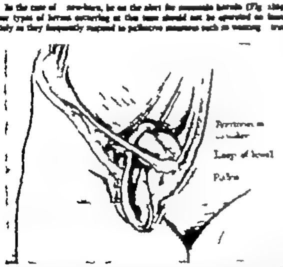


Fig. [illegible]. False reduction after rupture of the neck of [illegible] hernial [illegible]. Note that the [illegible] is lodged between the pubis and the peritoneum [illegible] [illegible] in place [illegible]. [illegible] the hernial sac [illegible] empty [illegible] the [illegible]. A [illegible] hernia. Unless the hernial contents are definitely replaced into the abdominal cavity one can never be sure of successful reduction. [illegible]

Fig. [illegible]. Infant with umbilical hernia.

Obstetricians should always be on the lookout for hernia into the umbilical cord while delivering the child. I know of two cases where [illegible] loop of intestine was ligated in cutting the cord when such hernia was present.

It should be remembered in replacing hernial contents that the more room there is in the hernial sac, the less room there is in the abdominal cavity. It may be possible to replace the contents of [illegible] large hernial sac into the abdomen, but if the tension is too great the patient will either succumb or the wound will burst open, resulting in evisceration and other unpleasant sequels. There are occasions where extraordinary voluminous hernias are better left alone (see Voluminous Hernia).

The omentum should not be ligated over the bowel as [illegible] piece of intestine may accidentally be included.

An effusion of [illegible] often clears up following the cure of the hernia since obstruction pressure from the hernia brought about the condition.

Ligatures should be sufficiently secure to bring about approximation but not so tight as to cause strangulation.

The hernial sac should be cut, whenever possible, flush with the surface of the peritoneum, and extirpated entirely.

After the incarcerated contents has been freed, each loop must be carefully examined for signs of gangrene. The constriction of the intestine involved in the hernia must be severed before it is repositied into the abdominal cavity. The omentum immediately outside the sac should also be carefully examined. Viability may be assumed if the bowel responds to pinching, if it bleeds, if it is shiny and elastic and if no gangrenous spots are discernible. The last are often found where you least expect it.

Devitalized bowel often responds favorably to treatment with hot saline solution. However [illegible] should be kept in mind that perforation of the involved segment may take place up to the seventh or eighth day after strangulation.

When gangrene of the bowel is definite, intestinal resection should include considerable adjacent intestine. Strangulation of intestines may cause [illegible] [illegible] ulcers occasioned by thrombosis in the mesenteric vessels.

In incarcerated inguinal hernias, intestinal hemorrhages occur in 50 per cent of the cases where forcible taxis has been used.

While dividing the tissues causing strangulation, exercise great care to avoid injury to the incarcerated bowel and bladder wall. It should always be done under visual guidance and preferably from without inward.

If operative methods are indicated, administer morphine, place the patient on his back, raise his hips, flex the thighs on the abdomen and allow him to wait for an hour. The hernia may reduce itself during that time.

If the patient [illegible] vomiting, resort to gastric lavage. When examining gangrenous intestines, [illegible] at the hernial opening if [illegible]. Then [illegible] [illegible] laparotomy opening into the inguinal wound, cover it with sterile towels, open the abdomen from above, bring the intestine through the wound [illegible]. Close the inguinal region, or the femoral, as the case may be. Institute ample drainage.

These operations are not simple and the beginner should make it [illegible] point, whenever possible, to have an experienced colleague at his side to aid him.

Hemorrhagic infarcts or subserous hematomas appearing on an incarcerated loop of intestine are indications for resection. These are likely to cause secondary intestinal stenosis from the formation of scar tissue. This dictates pri-

supposes that the surgeon is well acquainted with the technic of operation. If he is not, it is better for him to follow a more conservative course.

TAXIS

Dr. Roger T. Vaughan, in speaking on reduction of hernial protrusions, stresses the importance of thoroughly understanding the indications and contra-indications before attempting to reduce the strangulated or incarcerated mass. Vaughan admonishes that taxis is always indicated in patients who are considered bad operative risks, also when the strangulation is of short duration, except when much tenderness, redness and edema are present. He points out that hydroceles have been mistaken for hernial protrusions and attempts at reduction are made. It is obvious that nothing can be accomplished by such attempts other than injuring the parts concerned. It is also well to remember that the bowel portion of a hernial sac may permit transillumination when a recent intussusception from an antecedent congestion is present and thus mislead one to the belief that he is dealing with a hydrocele instead of a hernia. Where much blood is intermingled with the serous fluid no transillumination will, of course, be found. Soft and small hernias are reduced with greater ease than large and firm masses. In order of frequency of reduction, inguinal hernias may be reduced with greatest facility, femoral next, while umbilical and ventral hernias are the most difficult ones to reduce.

The essential factor in reducing hernias is to resort to a diffuse steady pressure with massage of the neck of the hernia, especially if [illegible]. The object of massage is to displace the edema from the neck of the hernia and to return the fluid in the strangulated bowel to the intestine above.

All manipulations must be gentle and under no circumstances should violence or sudden jerky movements be resorted to. Keep slowly changing your grip on the hernial mass and change pressure frequently to avoid fatigue.

In attempting to reduce inguinal, femoral and infraumbilical hernias, stand the patient on the back of the neck or head as nearly as possible (Vaughan hanging position). This position is not of much help in umbilical and supraumbilical hernias.

Before attempting reduction, resort to gentle lavage and a warming square [illegible]. Give morphine only (never ether or ethylene). [illegible] the methods of taxis and their dangers. Patients who should not be subjected to taxis will usually resent it because of the pain attending the maneuver.

After reduction has been accomplished, listen to the abdomen. If the obstruction is relieved, normal peristaltic sounds will be heard. Allow the patient to drink some water. If the obstruction is not relieved, the patient will continue to vomit. In cases where water is borne well, give citrate [illegible] ([illegible] ounces). Follow this with cleansing enemata.

If stool appears in all enemas followed later by oil, the obstruction is probably relieved. Test the stools for occult blood. The reason for this is that the mucosa is first to ulcerate where strangulation is present before the muscular and peritoneal coats lose their viability.

In debilitated patients, hernias quickly come down becoming incarcerated and irreducible. They are very tender. The abdomen in such instances [illegible]. Reduction is likely to be difficult because of tenderness and is not apt to be per-

manent. Be sure that the hernia came down before the pain set in in the abdomen if you diagnose strangulated hernia.

In [illegible] of the colon and acute obstructions of the small bowel, the distended abdomen causes the hernia to come down but reduction of it does not relieve the symptoms of obstruction.

On occasion, you may be able to reduce a strangulated hernia; usually, however, the patient will not even permit you to try this maneuver because of the intense pain produced. Should you succeed in reducing the hernia, symptoms of obstruction [illegible] persist.

Successful reduction of a hernia is not attained by forcible maneuvers or violence but by gentleness and persistence; the usual time consumed is about one half hour.

Increased intra-abdominal pressure is responsible for causing the hernia to emerge from the abdomen; therefore steady external pressure must aim to reduce it.

The half hour rule laid in attempts at taxis does not hold good in patients who are not operable because of cardiac decompensation, advanced age, etc. In such cases the time is extended, for these individuals may be saved in no other way except by taxis provided the strangulation did not last too long.

Hernial protrusions that have been down for only a day or less can usually be reduced, especially the inguinal variety which tends to strangulate more slowly than do femoral hernias. If only partial reduction can be attained, it will suffice provided, however, that the obstruction is relieved as shown by the test alluded to above. Incompletely reduced hernias are always a source of worry.

To Dr. Vaughan's governing valuable aphorisms the following data should be added: Reduction reduces operative mortality enormously. It does not make operation unnecessary—merely safer.

When the distension has disappeared and there is no occult blood in the stool, operate. It is imperative to differentiate between incarcerated, strangulated, inflamed and obstructed hernias. A x-quart enema and the x-ray are often of considerable diagnostic help.

LITTRE-RICHTER'S HERNIA

Richter's hernia is a rare unusual type of hernia. While this represents a form of strangulated hernia, it is characteristically associated with partial intestinal obstruction which is usually present in strangulated hernia. Only a part of the circumference of the bowel is caught and strangulated. The involved portion may rapidly become gangrenous although the lumen of the intestine remains open, to some degree. The portion of the engaged bowel resembles a small diverticulum of the bowel wall (Fig. [illegible]).

In Richter's hernia the sac is usually small and this factor prevents the engagement of the entire circumference of the bowel. The condition of the strangulated portion of the bowel wall depends on how long strangulation has been present and the size of the neck of the sac. In many of the earlier cases in which gangrene was present, subcutaneous rupture led to fecal fistulas. In most of these the fistula persisted; in only one case did the fistula close spontaneously (Ribbens).

Historical Notes. In 1700, Littré described 3 cases in which only a portion of the bowel wall was found in the hernial sac. Two of these were hernias later [illegible] as [illegible] Meckel's diverticulum, but the third could not be identified from his report. He believed that these diverticula were the result of the intestinal wall being pulled out into the sac. It was not until [illegible] that Meckel described the diverticulum that now bears his name, thus explaining the true nature of Littré

Fig. [illegible]. Richter's hernia. (Courtesy of Dr. E. [illegible] Cattell.)

[illegible]. The first complete scientific description of this type of hernia was made by Richter in [illegible]. He described this form of hernia as a small rupture. He [illegible] that the wall of the involved bowel was made up of the same layers and [illegible] as were present in the intestinal wall, [illegible] described by Meckel. In considering treatment, he recommended, if gangrene had not appeared, reduction aided by dilatation of the sac with [illegible] of gangrene was present he believed that reduction was dangerous and that no [illegible] should then be done. Treves suggested that this type of hernia be called Richter's hernia in order definitely to identify it and to differentiate it from the

hernia of Littré and other forms. The earliest report Treves was able to find was that of Guilielmus Fabricius Hildanus in [illegible].

The treatment of Richter's hernia is surgical. Operation should be done as soon as possible in order to avoid gangrene.

In the cases collected by Treves there was a mortality of [illegible] per cent in those not operated upon. With rare exceptions all those recovering spontaneously developed persistent fecal fistulas.

Cattell reported two patients with Richter's hernias. Both occurred in the femoral region and in each instance the terminal ileum was involved. In one, the appendix was encountered in the femoral sac beneath the engaged intestine.

The majority of these patients do not have complete intestinal obstruction so that strangulation may not be evident. Diagnosis is rarely made before operation. In all cases with symptoms suggestive of partial intestinal obstruction it is important to examine all possible hernial sites.

There are about [illegible] cases of parietal hernia reported in the literature. By an internal hernia Apple [illegible] was developed [illegible]. Two such cases have been observed at [illegible] clinic and another case was found during an autopsy.

Robert L. Rhodes reported three cases of partial enterocele (Richter-Littré) Hernia. These cases confirm Rumpel's observation that complete obstruction results from a two-thirds constriction of the bowel (two of Rhodes' cases) while one-third constriction gives only partial obstruction.

VOLUMINOUS HERNIAS

Voluminous hernias are often difficult to diagnose, especially if associated with pregnancy. It would be very unwise to operate in such cases before labor is completed. If the hernia is not too large relief may be expected at the hands of a competent surgeon.

The case depicted on p. [illegible] is one which precluded any surgical intervention. The chances are it would be impossible to force the herniated mass back into the abdomen and even if such were the case the operative shock would be likely to kill the patient.

The condition followed shortly after the patient was discharged from the hospital where she had been operated upon for suppurative appendicitis and the wound had not healed readily; evidently the layers of the abdominal wall failed to consolidate or the nerve supply was injured.

About six months after the operation, the patient noticed a lump on the site of the scar. It gradually enlarged until it reached the size shown in Fig. [illegible].

The principal factors involved in avoiding the occurrence of voluminous hernias are proper primary closure of the abdominal surgical wounds, and respecting the nerve supply.

Gerlach has reported that [illegible] large series of postoperative hernias following appendicectomies have been avoided by leaving the wound open, that is, only few plain catgut sutures placed in the parietal peritoneum to prevent prolapse of the bowel or omentum; no sutures were placed in the muscle, fascia or skin.

Postoperative hernias are not the only type which offer difficulties in the

Surg., Gynec., and Obstet., [illegible].
[illegible] Chirurg., Acta Scand. Chir., Vol. [illegible], p. [illegible].
[illegible] Surgery, Gynec., [illegible], Vol. [illegible], p. [illegible].

voluminous variety; inguinal, femoral and others frequently perplex the surgeon, especially those in which large portions of the intestines, stomach, uterus or other organs have descended into the inguinal hernial sac rendering it partially or completely irreducible because of the apparent inability of the abdomen to retain the herniated organs. (Figs. 1872-1873.)

Patients carrying these voluminous hernias have become accustomed to them through their long existence and while generally there is no great tendency to

Fig. 1872. Enormous ventral hernia.

acute symptoms due to strangulation, inevitably, on occasion, perplexing problems present themselves.

Careful examination of this type of hernia suggests the impossibility of replacing the herniated contents in the abdomen. Great force would have to be exerted which would doubtless cause injury to the intestines and other viscera, or there might be very decided retraction of the diaphragm caused by replacing the organs which would interfere with the functions of the heart and lungs or even resulting in asphyxiation.

It would seem, from the cases reported in the literature, that the best method

for dealing with hernias of this type surgically is to resect portion of the small intestine, which varies in length in different individuals from 5 to over 9 meters; from 3 to 3 meters may be removed in most cases without threatening the patient's life. Of course, the general physical state of the patient should be considered, as well as the length of bowel to be resected.

When confronted with voluminous hernias, Kocher's aphorism comes to my mind, "Wer einen Bruch so solchen Dimensionen ... such hernias ... *He who permits ... hernia to assume such dimensions should retain it.*" While many surgeons feel the justification of Kocher's admonition, there are instances in which even very large hernias can be remedied by proper operative intervention. Figure 1874 depicts an enormous ventral hernia complicated by intestinal obstruction in a patient who came under my attention at the Cook County Hospital. In Fig. 1875, lateral view of the hernia, shows on the apex of which large excoriated area is seen. Not to submit this patient to operation would seem to permit her to die without surgical aid. Exploration was decided upon. The abdomen was opened through a transverse incision and it was discovered that most of the large bowel and about two-thirds of the small intestine were found in the hernial sac. Reposition was a difficult task but was eventually accomplished. About the necessity of resecting segments of the bowel for purposes of diminishing the volume of the herniated mass. The patient made complete recovery. (Fig. 1876.)

Fig. 1872. Massive irreducible double scrotal hernia. (Mayo Clinic.) A considerable portion of the contents of the sac had been present since the pint quart was taken. The patient was operated on the left side four days after admission to the hospital. Bowel and omentum were firmly matted, greatly thickening the sac. It was found impossible to separate these without first opening the testicle and cord after which large opening in the abdominal cavity was closed. Recovery. ... Right side not operated on because we could not persuade to repair ... without ... complete removal of the testicle. (Courtesy of Dr. A. L. Loeffler, ..., From the ... Medical College.)

This experience emphasizes the necessity of heroic measures when the occasion arises. Not always, however are such efforts crowned with success and conditions arise where the herniated mass cannot be forced back into the abdomen.

In 1903, Becker reported case of enormous hernia which descended to the knee in man 50 years of age could not be held by truss and was only partially reducible. He performed laparoherniotomy resecting two meters of the small intestine (ileum) including the overlying mesentery. He then removed the testicle and cord and joined the ends of the intestine by means of side-to-side anastomosis. The wall of the hernia was reconstructed in accordance with Bassini's principles. The resection was done because Becker felt that the ab-

domen was no longer able to hold the herniated mass and forced reduction *would be likely to result in asphyxiation, due to the pressure on the diaphragm.*

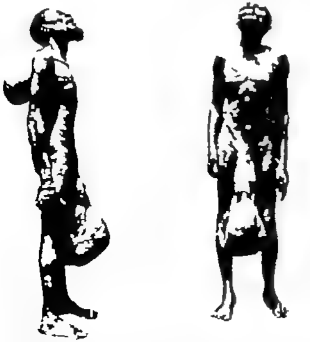


Fig. 1873. ... enormous right inguinal hernia reaching to the middle of the leg. Lateral and front views. ... years of age, of ... tribe of ... Contents of hernial sac ... about half of the urinary bladder and about ... feet of small intestine. Three feet of the latter were resected, the ... end-to-end ... Manchester procedure resorted to ... the ... hernial surgery ... Courtesy communicated to the author by Dr. G. Dumas, Central Hospital, ... French Cameroun, West Africa.

This method was first used by Maupertuis in 1899. Madelung, Jalland, Ponchet and Drak later used it successfully.

The case of an obese patient aged 53 is reported by Pototschnig. The patient, who had right inguinal hernia the size of an adult head and who was also affected with emphysema, was operated upon under spinal anesthesia. The sac revealed numerous loops of small intestine, the cecum, portion of the as-

cending colon and much adipose mesentery. About meters of the herniated *small intestine* were resected and the ends were united by means of latero-lateral anastomosis. The walls of the hernia were reconstructed in accordance with Bassini's principles; the patient made good recovery.

Fig. 1874. Enormous ventral hernia complicated by intestinal obstruction.

Dumas reported the case of patient 60 years of age who had left inguinal hernia of 9 years duration, which was about the size of child's head. The patient suffered no pain and did not wear truss. After time he suffered from

Fig. 1875. Fig. 1876.

Fig. 1875. Same patient ... lateral ... distribution.
Fig. 1876. Same patient five weeks after operation ... complete recovery.

gastric disturbances and the hernia enlarged after drinking much fluid and gurgling sound could be heard. Roentgenologic examination revealed much ptosed stomach, elongated and lobular with lower pouch corresponding to the

pyloric antrum situated in the hernial sac and joined with the remainder of the stomach by a strictured part which coursed through the inguinal canal. A radical operation resulted in the elimination of the gastric disturbances. Before operation, only slight reduction could be effected.

A case is reported by Ranzi [illegible] concerning a woman [illegible] years of age where the uterus and adnexa which were in the sac of an inguinal hernia were returned to their normal position and the sac removed.

Lenormant recommends the resection of a large portion of the intestine and mesentery in cases of hernia. He states that he encountered a voluminous hernia in a patient where the viscera seemed to have left the abdominal cavity. He replaced them easily and the patient recovered satisfactorily.

It may be well to remark here that the small intestine varies in length in many from about four and five-tenths to more than nine meters and that from two and five-tenths to three meters can be resected without serious physiologic phenomena which threaten the life of the patient. If resection seems to be indicated, the general state of the patient and the length of bowel to be removed should be considered.

Kesh reports the case of a man 84 years of age who suffered from an enormous inguinal hernia for 50 years. The scrotal coverings extended down over the lower third of the right thigh and the lower two-thirds of the left thigh. The hernial protrusion measured [illegible] inches in circumference at its widest part, contained omentum and a large mass of bowel and extended down to the left patella; the kidney, spleen and liver were prolapsed. Kesh considered surgery inadvisable here because: (a) it would be necessary to draw the ligaments and mesenteries away from the abdominal wall; (b) it would be impossible to replace the pitted and herniated viscera within the shrunken abdomen; (c) on account of the long-standing of the hernia and (d) because of the advanced age of the patient.

In that instance the contraindication for operation was justifiable; however, this would not hold true in all cases of hernia where resection of part of the hernial contents is advisable.

ABDOMINAL HERNIA

HERNIA OF THE LINEA ALBA

As the name implies, these hernias occur in the midline of the abdomen but do not involve the umbilicus (Fig. 1697). As a rule, these protrusions are usually encountered above the umbilicus. Hence these hernias are often referred to as "epigastric hernias." [illegible] may vary in size from that of a pea to [illegible]. The larger types are situated near the umbilicus. As a rule, most of these protrusions are very small in size, however.

Anatomically the linea alba lies in the midline of the abdomen between the two recti abdominal muscles and is an aponeurotic structure made up of the fusion of the sheaths of the recti muscles on both sides. It is narrower below the umbilical [illegible] than above it. It is connected with the peritoneum posteriorly but separated from it by the transversalis fascia (Fig. 1698-A).

The blood vessels run between the peritoneum and transversalis fascia, the same as in the rest of the abdomen. Blood vessels pierce the portion of the linea

alba lying above the umbilicus as well as the transversalis fascia causing them to be prolonged outward (Fig. 1698-B).

A very narrow space exists between the posterior sheath of the rectus muscle and the transversalis fascia. This space is so extremely narrow that, if there were an outward prolongation of the transversalis fascia at the point where the blood vessels penetrate it, the linea alba and transversalis fascia would be joined, obliterating the space entirely. In fact, Moschcowitz speaks of this space as hypothetical.

The opening in the transversalis fascia through which a blood vessel emerges to the surface is a locus minoris resistentiae which during increased intra-abdominal pressure yields and hernial protrusion results.

The falciform ligament of the liver is attached in the middle of the abdomen, slightly to the right of the linea alba. This consists of two layers of peritoneum enveloping a quantity of fatty tissue. In front, this adipose tissue is close to the transversalis fascia of the linea alba.

Figure 1698-C depicts a diagrammatic horizontal cross-section of the linea alba where it is penetrated by a blood vessel. Therefore, if an opening results in the transversalis fascia by reason of piercing by a blood vessel, the peritoneal fat of the falciform ligament would naturally be the first tissue to emerge through such an opening. Figure 1698-D depicts a cross-section of an ordinary epigastric hernia.

Fig. 1697. Hernia of the linea alba.

The reason why these hernias are usually of small size is because the openings in the transversalis fascia are very small while the fascia and other constituents of the linea alba are firm and resistant.

A hernial sac is usually not present in this class of cases. The peritoneal cavity is, therefore, not be entered during the repair of such hernias. Frequently wrong diagnoses are made in these cases because the dragging down of the fat and peritoneum of the falciform ligament causes symptoms referable to the stomach and a diagnosis of gastric disease rather than hernia is made.

Treatment. Make an incision in the linea alba over the hernial protrusion. The surgeon observes the adipose tissue attached to above and usually mistaking it for peritoneum. After he incises and dissects it, he recognizes he is dealing with omentum. The opening of the peritoneal cavity then offers a great deal of difficulty.

A better method is Moschcowitz's operation which is performed as follows:

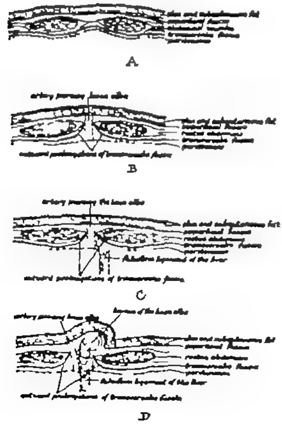


Fig. 1698. Topographic anatomy of the linea alba and its relation to hernia in this situation. (After Moschcowitz.)

Step 1. Make a small vertical incision over the middle of the hernia.

Step 2. Incise and retract the skin and subcutaneous fat, then exposing the fat nodule.

Step 3. Grasp the blood vessel, which is usually situated on the left side of the protrusion, and ligate. The fat is carefully dissected apart convincing the surgeon that he is not dealing with a true sac. Ligate the pedicle of fat to preclude secondary hemorrhage.

Step 4. Push the ligated stump back into the opening which is then closed with one or two sutures. Place the ligatures close to the bottom of the opening in the transversalis fascia. Close the skin as usual.

Comment. While strangulation of epigastric hernias is very rare, it is, nevertheless, occasionally encountered.

OBTURATOR HERNIA

This hernia egresses through the obturator canal which is situated in the upper external portion of the obturator membrane occupying the entire obturator

Fig. 1699. Hernia sac through obturator [illegible]. Right obturator hernia [illegible]. (Peres.)

foramen (Fig. 1699). It usually occurs in elderly women. It is difficult to diagnose and is usually recognized at operation for intestinal obstruction.

Normally the obturator canal is occupied by the obturator vessels which are enveloped in the sheath resulting from the prolongation of the pelvic fascia, a small amount of adipose tissue, the obturator nerve and at times a small lymph node. The canal is lined with periosteum and is covered by the pectineus muscle. The blood vessels course through an interspace in the obturator internus muscle.

The origin and development of an obturator hernia is the same as that of other hernias. In order to reach the thigh, the obturator vessels which run between the peritoneum and transversalis fascia of the pelvis pierce the transversalis fascia, forming an opening through this opening the hernia emerges in the following sequence. Anatomically the obturator vessels, after penetrating the transversalis fascia, are enveloped in a fascial sheath. A small cul-de-sac of pelvic peritoneum is pushed into the obturator canal alongside of the vessels and herniation results if a portion of an intra-abdominal viscus finds its way into the hernial sac. Besides bowel these hernias often contain, peritoneum, parts of the female genital organs (ovary, tube) or bladder.

The obturator nerve does not accompany the obturator vessels as it is separated from them by the pelvic fascia. Nevertheless, it is sufficiently contiguous so that the hernia may press against the nerve causing pains along its course (inner surface of the thigh) and extending to the knee joint. The phenomenon is spoken of as the Howship-Romberg symptom.

These hernias are usually small but on occasion they may become large and are covered by the pectineus muscle which may become stretched.

Treatment. Because the neck of the sac is situated so deeply in the abdomen, it is extremely difficult to ligate the neck of the sac, even after

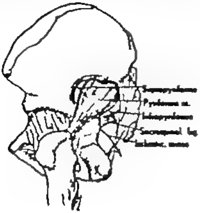


Fig. 18?a. Lateral view of the pelvic showing openings through which sciatic hernias may develop.

incising the pectineus muscle. If the hernia is a strangulated one, close proximity of the obturator vessels renders the division of the strangulating ring very difficult.

Step 1. Place the patient in Trendelenburg position. Open the abdomen.

Step 2. Bring out the afferent and efferent loops of the strangulated contents of the hernia. Avoid injury to the nerve and blood vessels. Manipulation of the contents of the hernial sac should be done with extreme gentleness.

Step 3. Withdraw the hernial sac and divide its peritoneum exposing the opening in the transversalis fascia.

Step 4. Close the opening with Pagenstecher linen or chromicized catgut.

Step 5. Obliterate the sac and close the peritoneum.

Comment. It should be recalled in dealing with a strangulated obturator hernia that the obturator vessels are branches of the internal iliac vessels, consequently lie slightly behind the neck of the sac. Not infrequently, the obturator artery is a branch of the deep epigastric or the external iliac artery and is likely to lie in front of it.

A. Randle Short states (personal communication): "In these cases the hernia cannot be closed successfully by suturing from within the abdomen, and recurrence is common. In recurrent cases, I fill the hernia cavity by inserting a piece of costal cartilage, and then close the peritoneum over it. After this there was no recurrence.

SCIATIC HERNIA

This variety is also called gluteal hernia; it is exceedingly rare. The different sites where it occurs are: at the gluteal artery above the pyriformis muscle; at the sciatic, internal pudic and inferior gluteal vessels below the pyriformis muscles (Fig. 18?a); the hernia may appear as a large pendulous tumor passing through the lesser sacrosciatic notch, accompanying the internal pudic vessels as they reenter the pelvis and may be mistaken for a perineal tumor (Fig. 18?b).

The first two types are so small and deeply imbedded that diagnosis is almost impossible. If these hernias become strangulated, the preoperative diagnosis is usually intestinal obstruction; the correct diagnosis is made after the abdomen is opened. Treatment is the same as that described for obturator hernia.

Fig. 18?b. Sciatic hernia. (Surgical Service, Cook County Hospital.)

LUMBAR HERNIA

This variety is rarely encountered. At one time it was believed that the only site for the hernia was the triangle of Petit which occurs over the crest of the ilium, bounded anteriorly by the external oblique and posteriorly by the latissimus dorsi muscle, the internal oblique, the transversalis muscles and transversalis fascia making up its base. However later observations have prompted the belief that this hernia emerges through another part of the lumbar region.

The course followed by the lumbar and circumflex iliac arteries is still controversial. They are covered with peritoneum, are branches of the aorta and lie upon the transversalis fascia, which they must penetrate to reach the surface; the resulting hiatus may thus mark the beginning of a hernia; these vessels penetrate the walls of the abdomen posteriorly and laterally. Blood vessels may pierce the triangle of Petit rendering a hernia here possible. Openings in the tendon of the latissimus dorsi, trigonum lumbale superius, etc., have been described. Guy van Alstyne (personal communication) recently operated on such a case. While exceedingly rare, it must be remembered that hernia in this situation does occur.

Treatment

No definite steps of procedure can be outlined in surgically attacking lumbar hernias because such operation will depend upon the anatomic structures involved and the peculiarities of the hernial protrusion.

INCISIONAL HERNIA

This type of hernia occurs at the site of a wound of an antecedent abdominal operation (Figs. 18?a–18?). Among factors contributing to the occurrence of incisional (postoperative) hernias may be recalled:

(a) Faulty suturing, unsuitable suture material, sutures which have been tied too tightly causing tissue strangulation.

(b) Infected wounds followed by sloughing of the fascial and muscular structures resulting in the weakening of the abdominal support.

(c) Wounds demanding drainage.

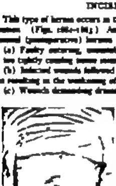


Fig. 18?a

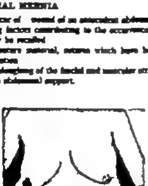


Fig. 18?b

Fig. 18?a. Recurrent postoperative hernia. Patient has been operated on [illegible] times.
Fig. 18?b. Hernia [illegible] an operative scar. Incisional hernia.

(d) Where closure of the abdominal wound is imperfect or impossible. For example, in cases where a portion of the abdominal wall must be sacrificed because of malignant tumors. It must be recalled here that in instances where the motor nerves to a single muscle or group of muscles have been accidentally severed during an operation and are not immediately repaired are often referred to as incisional hernias when, as a matter of fact, these are not really hernias: the muscles become paretic and atrophy, the transversalis fascia bulges; however, true hernia does not result.

Treatment

Step 1. Expose thoroughly the opening through which the hernial contents escape.

Step 2. Make an adequate incision exposing fully the normal structures adjacent to the hernial opening.

Step 3. Open the peritoneum and separate all adhesions.

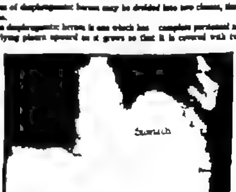
Step 4. Reduce the hernial contents and close the peritoneum as usual.

Step 5. Unite the superimposed freshened abdominal layers with chromic catgut. Mattress suturing and skin clamps are essential.

DIAPHRAGMATIC HERNIA

Cases of diaphragmatic hernia may be divided into two classes, that is, true and false.

True diaphragmatic hernia is one which has a complete peritoneal sac, forces the overlying pleura upward as it grows so that it is covered with two serous



[illegible] 18?. Diaphragmatic hernia. Chest, greater portion of stomach contained in the left thoracic cavity.

layers. false diaphragmatic hernia is caused by trauma and has no peritoneal sac. The difference between the two is readily noted in recent cases but in those of long standing, the prolapsed hernial contents which are characteristic of the "false" variety become covered by a pseudoperitoneal sac (Fig. 18?).

Diaphragmatic hernias are divided according to their origin as (1) congenital and (2) acquired. The congenital type is very rare. The acquired type may be either "true" or "false". The true type is one in which there is a protrusion of intra-abdominal contents into an acquired sac. The false (acquired)

diaphragmatic hernia may be the result of a wound penetrating the thorax, diaphragm, pleura and peritoneum, or of a crushing force against the thorax.

The more frequently encountered form is explained on the following basis: peritoneum covers the entire diaphragm. Immediately under the peritoneum is the diaphragmatic fascia. Careful examination reveals perforations in the diaphragm and diaphragmatic fascia allowing the passage of certain structures from the abdomen to the thorax and vice versa. These perforations are frequently the beginning of an acquired diaphragmatic hernia.

The apertures in the diaphragm are:

(a) Between the sternal and costal portions of the diaphragm where the superior epigastric artery penetrates.

(b) Where the musculophrenic artery pierces it.

(c) The opening of the esophagus.

(d) The opening of the aorta.

( ) The opening for the vena cava.

(f) The foramen of Bochdalek.

The size and quantity of the contents of a diaphragmatic hernia vary. The stomach, transverse colon and omentum are often contained in the hernial mass. This accounts for the frequently complained of gastric distress. The heart and pericardium are frequently displaced to the opposite side. Tympany may be elicited in the thorax. When the stomach is extended, dyspnea may be complained of.

Treatment

In attacking surgically cases of diaphragmatic hernia in which the defects in the diaphragm are accompanied by considerable prolapse of a large portion of intestine, the undertaking is beset with many dangers.

The two methods of surgical approach are: ( ) transpleural; (b) transperitoneal.

The advocates of the transpleural method point out that it is preferable because it permits freer handling of the hernial contents and affords better opportunity for the suture of the hernial aperture in the diaphragm and thoracic wall.

Transpleural Operation

Make a long incision in the intercostal space overlying the hernia. A rib spreader correctly used will give sufficient exposure without the necessity of resorting to rib resection. If such procedure is insufficient, do not hesitate to resect one or two ribs. A pneumothorax should be avoided. This may be accomplished by a properly controlled intratracheal insufflation anesthesia or pressure cabinet.

In true diaphragmatic hernia incise first the diaphragmatic pleura, then the diaphragmatic peritoneum. In the false variety the hernial contents are exposed. Liberate all adhesions and replace all contents into the abdomen. Trim away the redundant portion of the sac. Suture the hernial opening in the diaphragm, each suture grasping in its bite pleura, endothoracic fascia, diaphragm, diaphragmatic fascia and peritoneum. Expand the lung by means of intratracheal insufflation anesthesia or with the pressure cabinet and close the aperture in the

thorax. A temporary resection of the costal arch, after the procedure of Marwedel is often very helpful.

Charles Harrison Arnold of Lincoln, Nebraska, suggests that when operating on a diaphragmatic hernia, using the thoracic approach, that one week before operation the patient have an artificial pneumothorax on successive days, until the lung is completely collapsed on the affected side. He finds that by so doing, all shock is obviated when the chest is opened at operation time.

He also suggests that after making the skin horse-shoe incision down to the ribs, that the soft tissues be dissected backward for one inch around this entire incision, and with an electric drill, holes be made through the ribs one inch distant

Fig. [illegible]. Ribs of the right side in their natural position, seen from right. A. Horse-shoe incision. B. Drill holes in ribs. Wires in place.

from each other so that the ribs can be united by placing a rustless steel wire through these openings and approximating the cut ends of the ribs, thus eliminating pain and stabilizing the entire chest wall. (Fig. [illegible].)

F. E. Truesdale[1] describes his procedure as follows:

In determining the method of approach, many factors must be considered. Laparotomy is more direct, requires less time and produces less shock. However it has limitations. An extensively adherent viscus within the sac, combined with adhesions between the sac, lung and pericardium, may add much to the difficulties encountered. In traumatic cases and in congenital cases in children, adhesions and distended hollow viscera sometimes prevent reduction of the hernia from below. Olmsted reported that he had not used the thoracic route in fatal case. Olson pointed out the fact that when the stomach is markedly dilated, it cannot be pulled through a narrow aperture in the diaphragm from below.

The x-ray film is of assistance in determining the method of approach. When the cardiac end of the stomach, which is visible by x-ray above the diaphragm with the patient in the Trendelenburg position, does not descend when the patient is changed to the upright position, one concludes that adhesions have formed

[1] Am. Jour. Surg. Vol. [illegible] No. [illegible] May [illegible]

between the stomach and the sac and one employs the thoracic route. It is not maintained that adhesions of the stomach within the sac cannot be severed from below. With the colon drawn down into the abdomen, adhesions within the sac are put on tension and their division, though somewhat difficult, can be accomplished. However adhesions of the sac to the esophagus, pericardium and pleura are shut off from the abdomen and their division becomes difficult if not impossible.

Whichever method of approach is employed, operation is predicated upon the knowledge that acquired hiatus hernia in the adult presumably is caused by loss of tone in the diaphragmatic musculature partially encircling the esophagus. A loss of tone and an abnormal spreading of the muscle structure forming

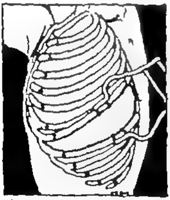


Fig. [illegible]. Seventh and eighth ribs severed posteriorly according to the method of Roberts. Courtesy of Dr. F. E. Truesdale.

the hiatus result in what might be termed a "tooth sucking band" with retardation of the food column before it enters the stomach.

Truesdale Technic for Diaphragmatic Hernia by the Thoracic Route

Step 1. Truesdale believes that the approach described by Roberts of London generally gives satisfactory results. Make the usual incision of the soft tissues dividing one or more ribs (usually the seventh and eighth) posteriorly to the tubercle.

Step 2. Divide the intercostal planes along the entire length of the incision. Use a self-retaining retractor with or without illumination. The former gives adequate approach and light to expose those "parts of the diaphragm ordinarily considered inaccessible." (Fig. [illegible].)

Truesdale admonishes that despite the possibility of saving ribs he found that under certain conditions such as the repair of a very extensive aperture,

it is of unquestionable help to excise one or more ribs particularly when the hernia occurs at the foramen of Bochdalek.

Step 3. If there is no sac, sever adhesions and reduce the herniated organs. If sac is present dissect it free from adhesions and free it from the diaphragm. The opening at the hiatus of the diaphragm appears as shown in Fig. [illegible].

Step 4. Grasp the outer extremity of this opening with a pair of intestinal forceps and draw it laterally as the borders are made taut (Fig. [illegible]).

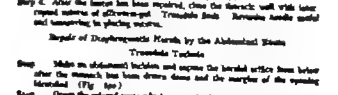


Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Appearance of hernial aperture.

Fig. [illegible]. Margins of hiatus made taut by traction to the left for suturing.

Fig. [illegible]. Hernial aperture closed after suturing.

(Courtesy of Dr. F. E. Truesdale.)

Step 5. Approximate these edges with a running suture of silk reinforcing the suture line with interrupted silk sutures. (Fig. [illegible].)

Step 6. After the hernia has been repaired, close the thoracic wall with interrupted sutures of silkworm-gut. Truesdale finds a Reverdin needle useful and time-saving in placing sutures.

Repair of Diaphragmatic Hernia by the Abdominal Route

Truesdale Technic

Step [illegible]. Make an abdominal incision and expose the hernial orifice from below after the stomach has been drawn down and the margins of the opening identified. (Fig. [illegible].)

Step [illegible]. Grasp the relaxed crura which appear in the form of a rounded muscle bundle, with intestinal forceps, and draw them into the field of operation. Bear in mind the fact that the normal hiatus permits the introduction of one or two fingers. It is therefore essential that care be exercised not to suture the musculature too closely about the esophagus. While the sutures are being placed, a metal depressor about an inch in width is used to guard against injury to the esophagus (Fig. [illegible]). If the muscle on the weak side is but slightly relaxed, the two sides may be evenly apposed by placing sutures vertically anterior to the esophagus, then the hiatus is reduced in size to approximately normal. Truesdale points out that such method of repair has one objectionable feature and that is that the intended closure of the hiatus consists of actually uniting the two halves of the diaphragm and, while the diaphragm contracts and relaxes, the powerful traction on the suture line may result in a recurrence of the hernia. (Fig. [illegible])

that means that the undesirable resort to

of some purpose. Again, in a typical

the two sides of the hiatus appears in the

right muscle bundle at its base. In order to suture this triangle vertically the sutures must be placed at greater intervals at the two left sides which results in shirring on the left side. However, if both sides of the triangle are brought horizontally or laterally at a tangent as shown in Fig. [illegible], the closure of the hernia is limited to an operation on one half of the diaphragm resulting in lessened tension of the suture and a decrease in the liability to recurrence.

Step 3. Close the anterior angle vertically with two or three interrupted sutures as shown in Fig. [illegible]. This will add somewhat to the strength or retentive capacity of the horizontal sutures as shown in Fig. [illegible].

Fig. [illegible] Fig. [illegible]

[illegible]. Diaphragmatic hernia. Bilateral crura outlining the hernia.
Fig. [illegible]. [illegible] diaphragm [illegible] while inserting sutures.
(Courtesy of Dr. F. L. Truesdale.)

Comment. Truesdale points out that this operation of approximating the pillars of the diaphragm is similar to that used in joining the levator ani to strengthen the pelvic diaphragm. He also draws a convincing analogy between the anatomy of the central portion of the diaphragm and the muscle structure of the floor of the pelvis which supports and encircles the rectum. (Fig. [illegible].) The crura of the diaphragm are tendinous here. They pass forward and inward converging to form an arch beneath which pass the aorta and thoracic duct. It is from this arch that muscle fibers diverge so as to encompass the esophagus. A study of the origin and disposition of the levatores ani muscles reveals a similar arrangement.

Dealing with the Hernial Sac

This is a difficult process by either method. The approach to it was found more accessible by Sauerbruch and Lahr when dealt with from above. It may be separated readily from adhesions and disposed of in a manner practiced in umbilical hernia. While complete removal of the sac is desirable, plication as practiced by [illegible] has been resorted to. When the sac is approached from below it is drawn down to a level where it is most accessible, is dissected free and

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Vertical [illegible] of the [illegible].
[illegible]. Lateral closure of the crura.

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Vertical closure of anterior angle.
Fig. [illegible]. Closure completed.
(Courtesy of Dr. F. L. Truesdale.)

removed. Truesdale questions the wisdom of phrenic avulsion in these operations. Atrophy of the diaphragm has been shown to result in cases where the surgeon resorts to paralysis of the phrenic nerve in order to facilitate surgical repair of the hernia. Crushing of the phrenic nerve should be resorted to to ensure temporary paralysis instead of permanent. Injection of the phrenic nerve with 70 per cent alcohol may be done.

PERINEAL HERNIA

This name applies to hernias occurring at the pelvic outlet, emerging from the true pelvis either through or between the fibers of the levator ani and other muscles forming the "pelvic diaphragm." It may occur either behind the rectum or in front of the bladder.

A B

Fig. [illegible]. A structural comparison of the diaphragm with the pelvic floor. A. Posterior view. B. Anterior view of [illegible] diaphragm pelvic floor.
(Courtesy of Dr. [illegible] L. Truesdale.)

INTERNAL HERNIA

(See Intestinal Surgery, p. [illegible])

In this variety of hernia the sac is formed from normal physiologic pre-tensions of the peritoneum. It may find its way (a) through the foramen of Winslow into the lesser peritoneal cavity; (b) where the duodenum joins the jejunum; (c) in the fossae around the cecum; (d) at the intersigmoid fossa which occurs on the left side of the root of the mesosigmoid and (e) occasionally in blind fossae near the top of the bladder.

The majority of these cases are diagnosed preoperatively as intestinal obstruction, their true nature being disclosed at operation. Therefore, the procedure is the usual emergency operation. Two loops of bowel, one distended and one collapsed, show the way to the affected zone. The loop which is collapsed is much more easily followed.

In instances where the hernia is strangulated, manipulation may be effective in obtaining reduction. If this fails, open the neck of the sac carefully avoid injuring the surrounding vessels; this should be particularly observed in the case

of left-sided duodenojejunal hernia where the inferior mesenteric vessels may easily be injured. After the intestines have been reduced, the sac may be dealt with in different ways. Obliteration of the sac may be out of the question on account of its size, because it is surrounded by large vessels or because a part of its wall is made up of intestine. Suturing of the sac or its neck may be dangerous on account of the size of the sac and the presence of large blood vessels; such closed sac is liable to become infected and cause peritonitis. It seems better under such circumstances to leave the sac alone regardless of the chance of possible recurrence.

THE USE OF AUTOPLASTIC SUTURES IN HERNIA

Comment. W. E. Gallie endeavors to overcome the drawbacks in surgical operations for hernia by using autoplastic sutures of fascia lata. The results, in experienced hands, are satisfactory. Gallie states[1] that thoughtful analysis of the results of the operative treatment of hernia in adults will convince the most sanguine that there is much room for improvement. The percentage of recurrences varies greatly with the experience and skill of the operator, but even in the hands of the most skilled, recurrences after the closure of large ventral hernias are very frequent. Gallie's researches on the causes of failures with fascial transplants caused him to evolve this method. The blame for the recurrence of the hernia must be laid to the character of the healing between the transplant and the surrounding tissues, and because surgeons rarely take the precaution to remove the areolar membranes from the surface of the transplant and the edges of the defect. The adhesion, therefore, can have only the strength of these areolar membranes, and can be of no importance whatever in preventing the separation of the hernial ring. He also states that the surgeon must place his whole trust in the character of the healing which occurs, the strength of which is very uncertain. The light scar-tissue which develops between overlapped aponeurotic surfaces is not equal to the strain which must be resisted in large ventral hernias.

Ventral hernia seems to be ideal for closure with living sutures. The whole responsibility for a cure is placed upon the sutures themselves. There is practically no limit to the number of sutures that may be inserted, so that it becomes simply a matter of the judgment of the surgeon as to how many layers of sutures are necessary to restore the abdominal wall to its normal strength. The chief precautions which must be observed are to see that the sutures are woven securely into the tissues surrounding the opening, and that these tissues, wherever possible, include aponeurosis. It is preferable to make no preliminary dissection of the edges of the hernial ring into their various layers as the grip of the sutures is most secure when they are undisturbed. If the edges of the ring can be drawn together without too great tension, so much the better; but if they cannot, the gap which is left may be closed by weaving the sutures across the opening as in the darning of a sock.

Save time by having an assistant secure and prepare the sutures. A long incision is made on the lateral aspect of the thigh; expose the fascia

[1] British Journal of Surgery, 1920.

lata. Remove the fat and areolar tissues over the whole area from which the sutures are to be taken. Make a small longitudinal incision through the fascia through which it is enlarged to the required length. A second incision in the fascia is made [illegible] quarter of an inch lateral to the first, and one end of the suture is passed through the eye of [illegible] large curved needle, and tied securely after transfixion with fine silk. Cut the terminal end of

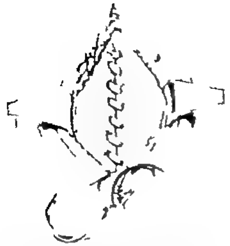


Fig. [illegible]. Drawing of the repair of ventral hernia with sutures of fascia lata. Insertion of the first row of sutures which brings the edges [illegible] the defect together [illegible] as they will meet without great tension. (Courtesy of Dr. W. E. Gallie.)

the suture free and tie [illegible] fine linen ligature around it to prevent splitting. In taking the first stitch the needle is passed through [illegible] length portion of the edge of the gap to be closed and then through the terminal end of the suture. In this way [illegible] slip-knot is produced which forms an excellent anchor. (Fig. [illegible].) The suture is woven strongly into the edges with as many bites as seem necessary and passed backward and forward across the opening until its whole length is used up. Owing to the slippery character of the fascia it will be found useful to anchor the sutures at every second or third stitch by some form of knot. When the first suture has been used up [illegible] second may be attached to it in the same way as pieces of tennis gut are fastened together, and the sewing continued. In this way

one suture after another may be inserted until the opening is completely closed. The suture is finally ended by splitting its terminal portion into two strands which are tied together about the suture in [illegible] triple knot. This knot should be made secure by transfixing it with [illegible] catgut ligature which will hold its loops in contact until they become firmly healed together.

Fig. [illegible]. Drawing of the repair of ventral hernia. Insertion of second row of sutures. [illegible] (Courtesy of Dr. W. E. Gallie.)

(Fig. [illegible].) Close the gap in the fascia if not too large; otherwise leave it alone. Care should be taken that each loop of the suture passes through strong aponeurotic tissue, well back from the edges of the opening, so that all possibility of cutting out is avoided.

When the healing process is complete the abdominal defect is filled with an aponeurotic structure which is comparable with the linea alba.

Whatever the cause of the recurrence, the indications are that in operations for inguinal hernia in adults definite precautions must be taken to have the abdominal wall medial to the internal ring as strong as it normally should be, and if there is any possibility of the posterior wall of the canal

being weaker than normal, it must be supported by some form of plastic operation which is more certain than the ordinary methods of suture.

It is very problematical whether the structures which are sewn to Poupart's ligament really do stay in this position for any length of time. In not one instance, despite the fact that the records showed that the conjoined tendon and the sheath of the rectus had been sewn to Poupart's ligament with kangaroo tendon or catgut, did Gallie find these structures together at the time of the second operation. This observation I can substantiate.

These findings have produced [illegible] doubt as to whether the sewing of the muscles and conjoined tendon to Poupart's ligament with ordinary sutures is ever [illegible] factor in preventing recurrence of the hernia. If, before inserting the sutures, all areolar membranes were removed from the surfaces which were placed in contact, and particularly if these surfaces were scraped and scarified, the amount of adhesion was greater; but if the normal action of the muscle tended to produce definite strain on the line of suture, the scar-tissue soon became stretched and the intention of the operation defeated. "These results demonstrate the folly of dragging structures such as the abdominal aponeurosis, the conjoined tendon, and the sheath of the rectus out of their normal positions to suture them to Poupart's ligament in the hope of permanently strengthening the abdominal wall," says Gallie.

In the case of direct inguinal hernia the defect in the ordinary Bassini operation has frequently been recognized, and many attempts have been made to improve on this operation by filling the defect in the abdominal wall with muscular or aponeurotic structures which might be able to withstand the strain. These operations all have the defect that they depend for their success on the healing together of fibrous or muscular structures, [illegible] factor which unfortunately cannot be depended upon.

The structures about the inguinal canal are peculiarly suitable for the use of living sutures. With [illegible] sufficient number of strips of fascia lata, the weak spot in the abdominal wall can be filled up completely without any disturbance of the normal anatomical relations and without any dependence on the uncertain process of healing.

The incision is made so as to allow perfect exposure of the spine of the os pubis and the insertion of the conjoined tendon and the rectus sheath. After splitting the external oblique, the upper leaf is reflected until [illegible] good view is obtained of the internal oblique aponeurosis. The sac is dealt with in the usual manner, although occasionally Gallie has done nothing more than to push it backward out of the way. The first suture of fascia lata, [illegible] quarter of an inch wide, is then anchored securely into the rectus sheath close to its attachment to the pubic bone. The needle is now passed behind the spermatic cord to pierce Poupart's ligament at its insertion into the pubic spine. If possible it should be made to pick up the periosteum to make the security of its fixation more certain. When the suture is drawn taut, the weakest spot in the abdominal wall, namely that which lies behind the external abdominal ring, is filled with [illegible] tough aponeurotic tissue which effectively prevents any bulging through the ring. (Fig. [illegible].) The sewing is continued in an outward direction, drawing the internal oblique muscle to the reflected portion of Poupart's ligament behind

the cord, until the position of the internal ring is reached. Here the suture is locked and then carried to the outer side of the ring, where [illegible] supporting stitch is inserted. In this way the cord, at the point where it disappears through the abdominal wall, is surrounded by [illegible] fibrous ring which will effectively prevent the development of [illegible] hernia at this point. By locking

Fig. [illegible]. Repair of inguinal hernia. Drawing of the repair of an inguinal hernia with sutures of fascia lata. Insertion of first row of sutures which binds the internal oblique and conjoined tendon to Poupart's ligament [illegible] (Courtesy of Dr. W. E. Gallie.)

each stitch at this stage the possibility of undue constriction of the cord is prevented. It is of value to permanently cover the peritoneum with [illegible] thick layer of muscle which will prevent the protrusion of peritoneum through the chinks of the next layer of sutures, which is the important one in the prevention of recurrence. This layer commences at [illegible] continuation of the first, at the outer side of the internal ring. The needle takes a solid bite of the oblique aponeurosis at its point of fusion with the external oblique and is then passed behind the cord to pick [illegible] Poupart's ligament. The

suture is carried backward and forward across the space, with frequent lock-stitches, until the sheath of the rectus is reached, and this also is woven to Poupart's ligament until the whole space is filled with fascia down to the pubic spine (Fig. 1902). No attempt is made with the second row of sutures to drag the abdominal aponeurosis and the rectus sheath out

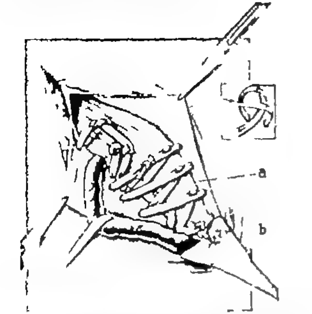


Fig. 1902. Repair of inguinal hernia. Drawing of the repair of an inguinal hernia. Insertion of second row of sutures between the external aponeurosis and Poupart's ligament. These sutures are not drawn together, but the natural fascia is filled in with ... Figure formed by the fascial sutures. a, Line of junction of the aponeurosis of the external and internal oblique muscles to the abdominal aponeurosis. b, ... of sutures. Insert shows each method form of lock-stitch. (Courtesy of Dr. W. E. Gallie.)

of their normal positions. No greater tension is exerted on the sutures than is sufficient to make them lie flat. The whole idea of the operation is to fill the weak spot in the abdominal wall with what may be called fingers of living aponeurosis. What one does with the external oblique is of relatively little importance. Usually in direct hernia it is too weak to be of any value to the surgeon.

In many oblique hernias, however, the posterior wall of the canal is not normal. The simple removal of the sac in these cases, therefore, leaves

the posterior wall of the canal very weak and quite unfit to withstand the usual intra-abdominal pressure. These are the cases which call for some form of repair of the abdominal wall.

The operation for oblique hernia consists of supporting the weak spot by a permanent meshwork of fascia lata which is sufficient to withstand all variations of abdominal strain.

W. H. Ogilvie points out[1] that Poupart's ligament is composed entirely of strips with a long arrangement having very few connecting fibers. The passage of a double row of sutures about one-quarter of an inch in width and threaded with very coarse needles as necessary to carry them, which tends to split up the ligament into a bunch of disconnected fibers. This

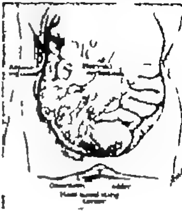


Fig. 1903. Epiplocele.

laceration of the main tissue is a possible reason for recurrences which have been reported from time to time following Gallie's operation for inguinal hernia. Ogilvie has seen only one such occurrence which happened in the case of a physician on whom he operated a year previously, for direct hernia, by the fascial suture technic. He states: "I have, however, been so distressed by the irregular appearance of Poupart's ligament at the end of the operation that I have abandoned the fascial strips for silk threads." Ogilvie further points out that silk is very much stronger than any living suture material of considerable size and, while it is, of course, a foreign substance, it is not absorbed. It is not resented by the tissues, remaining permanently incorporated in fibrous tissue as a harmless foreign material. Silk repair is carried out in a very similar manner to fascial suture, the point being that the silk is not used to draw the structures together but to form a lattice work, bridging the deficient posterior wall of the inguinal

[1] Operations of Surgery, Butterworth and Tanner, 1937.

canal and extending to Poupart's ligament below, and the outer border of the rectus abdominis sheath above and medially. It holds in its meshes the conjoined tendon and cremaster muscle, all of which blend to form a pliable and tough fibromuscular sheath. No. 4 silk, about 12 inches long, threaded on a small Mayo needle is used. The method is a modification of W. Sampson Handley's "Darn-Barytone method" described in 1918.

POSTOPERATIVE EPIPLOITIS

The author and Phil Thorek observed such cases (Fig. 1904). The presence of inflammatory and suppurative lesions in the omentum is by no means rare. Vegasse found less than one case reported in the literature. Abdominal operations may or may not be the origin of the condition. It may result from the presence of a foreign body or from an inflammation extending from some adjoining organ. In the cases following abdominal operations, their cause has been attributed to ligatures which entered necrotic patches or to ligating inflamed tissues of the omentum during a herniorrhaphy, appendectomy or any procedure involving the omentum, especially if it has been resected.

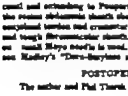


Fig. 1904. Healed hernial scar. Tumor mass. Incision for epiploitis and biopsy.

Epiploitis is of two types: (1) the chronic or Schnitzler-Braun type which manifests itself from a few weeks to a year following operation and (2) the acute or Kümmell-Schnitzler type which seems to originate from an embolus or thrombosis and may be characterized by symptoms very much like acute appendicitis or some other abdominal condition.

Emerson reported recently three cases of inflamed and hypertrophied omentum in obese patients which followed submandibular ... The omentum had not been resected in any case. Two cases which followed pelvic and abdominal operations were reported by Arnold. The omentum had not been touched during either procedure but in each instance the patient had left the hospital feeling not quite normal and the symptoms of abscess manifested themselves a few weeks later. In one of the author's cases epiploitis followed herniotomy (Fig. 1904).

Another case was recently operated on by the author at Cook County Hospital. It concerned a middle-aged man suffering from a left indirect scrotal hernia. During operation the sac was found filled with serosanguineous fluid but no hernial contents could be discovered. The small bowel was pulled down through the opened inguinal canal but no explanation could be found for the existing bloody effusion. The thought that a strangulated loop of bowel had been reduced and escaped our attention caused me to excise the sac, repair the inguinal canal and open the abdomen through a left transrectus incision. This disclosed that a large portion of the omentum showing all macroscopic evidences of a chronic epiploitis had been contained in the hernial sac when it became

[1] J.A.M.A., April 30, 1932, Vol. 98, pp. 1526 and 1532.

incarcerated and the bloody effusion was thus explained. It is possible that the reduction into the abdominal cavity took place during anesthesia, hence could

Fig. 1909.

Fig. 1910.

Fig. 1909. Chronic epiploitis forming the contents of hernial sac.
Fig. 1910. Postoperative epiploitis. Magnified ... diameters. Omentum shows marked inflammatory changes.

not be discovered during operation. The affected portion of the omentum was resected and the abdomen closed (Figs. 1909-1910).

THE INJECTION TREATMENT OF HERNIA

C. Jennings Marshall (Med. Press and Circular, Oct. 19, 1938) reminds us that the injection treatment for hernia is a century old, originated by Velpeau and recently revived with the "usual ticket of the plagiarist." A variety of formulas are used.

Proliferation and obliteration of the sac and fibrosis of the deep parts of the inguinal canal is the aim, the former a rather speculative probability. Toxicity and complications are not rare. Frequent injections are required (not infrequently 20 or over). A truss must be worn during the treatment and for some time afterward. "In general the treatment is reasonably successful according to its exponents' figures in the type of case in which surgery is most uniformly effective, whereas on the same basis it is quite undependable in the degenerative cases in which intelligent surgery will secure still a high proportion of good results" (Marshall). The author has seen one case of gangrene of the spermatic cord and testicle following an injection of a sclerosing substance for the "cure" of an inguinal hernia by a "rupture specialist." Harris and White (J.A.M.A., Vol. 111, No. 11, p. 1013, 1938) point out among their conclusions that this method of treatment "is not simple and necessitates detailed care over a considerable

period The most important single factor in the technic is the selection and application of [illegible] truss They conclude by pointing out that in general, the end results of the treatment of hernia by injection are not comparable to those obtained by operation. These results, however are sufficiently good to recommend this treatment when operation cannot be considered because of economic, personal or physical reasons, while Robert Slater (New England Journal of Surgery Vol 2, N [illegible] 3, p 695) points out that twenty patients with hernias were treated by the injection method and carefully followed. At the end of four years two patients were cured. Slater believes that the injection treatment of hernias is not satisfactory and should be used only [illegible] hen the patient must not be operated on and then only after the method of treatment and its potentialities for cure have been fully explained to the patient.

Ignatz Mayer of Detroit reintroduced the injection treatment and claimed 98 per cent of cures. The irritants used for injection are varied: tannic or gallic acid, zinc sulfate, carbolic acid, thyol, pinus canadensis, [illegible] soap solution derived from psyllium seeds, etc. The truss must be worn night and day for [illegible] prolonged period. Early tissue reactions cause more or less thickening which may temporarily prevent the hernial contents from descending, masking the true state of affairs and cures claimed where not justified. Leonard Erdman recalls that Frank A. Kelly of Detroit [illegible] he worked with Mayer and subsequent to the latter's death followed many of Mayer [illegible] patients, states "[illegible] are not sure that we have cured anyone" and that he believes that about [illegible] per cent of hernias may be cured. Reliable statistics indicate that one may expect one cure in every [illegible] patients suffering from hernia. Coley (New York) reported 81.05 per cent relapses following the injection treatment.

Mayer's solution consists of

[illegible]	
Phenol (crystal)	[illegible]
Glycerin	[illegible]
Aqua [illegible]	[illegible]
Ext. [illegible] (fluid)	[illegible]
Aqua Dest. [illegible]	[illegible]

Of this solution [illegible] 1-2 cc. are injected.

Place the patient on his back [illegible] elevate his hips slightly An ordinary hypodermic syringe with [illegible] needle of about [illegible] gauge is used. Prepare the field of operation as usual. Local anesthesia with [illegible] per cent solution of novocain is satisfactory

The aim is to inject the musculo-fascial structures about the rings and along the inguinal canals Place [illegible] gauze pad over the puncture after withdrawing the needle Keep the patient recumbent for about 10 minutes or so, having him compress the site of the injection during that time

Injections are made at three-day intervals for about two weeks Only the smallest dose of the preparation should be injected at first, in order to ascertain reactions [illegible] when no untoward manifestations are observed the dose is gradually increased. The truss is worn for about two months.

Part VI

SURGERY OF THE PELVIC REGION

ORIENTATION

Many [illegible] general surgeon not infrequently recalls that he has built his reputation on the success he has attained in surgery of some urologic operation (Chapter XL), or in performing some noteworthy gynecologic procedure (Chapter XXXIX) Both of these sections of the work have been thoroughly entered into and every form of operation in both chapters described as fully as possible

The surgeons of today are built on the sacrifices and researches of the masters of the days gone by Abernethy, Sir Astley Cooper John Hunter Sir Henry Thompson, Jean Civiale, Félix Guyon, Joaquin Albarran, Bottini, Légeu, Max Nitze James Israel Thiersch, Freyer, and in our own country Samuel Gross, J. H. Bigelow Hugh H. Young, Cabot, Bransch, Keyes, Van Buren, Belfield, Hinman and others made urologic history

Operative gynecology started with Jacob Hofer, [illegible] sow-gelder, who in 1500 performed [illegible] successful Caesarean section upon his own wife She lived to be seventy-seven years of age and bore other children. Through the centuries, to our own time notable contributions were made in gynecologic surgery by pioneers to mention only Marion Sims, McDowell, Emmett, Tait, Martin, Doyen, Wertheim Howard Kelly Simpson, Kenig Alexander Schauta, Kocher and others.

The general surgeon must always keep in mind that the term "minor surgery [illegible] misnomer A distinguished colleague and myself were observing an individual struggling [illegible] him performing [illegible] circumcision The details need not be described. I ventured the question Is there such [illegible] thing as minor surgery?" "No, replied my colleague [illegible] there [illegible] not, but there are 'minor surgeons. Harold Burrows describes [illegible] startling disaster in an operation for varicocele After the surgeon had made the usual incision he grasped what he thought was the spermatic cord He applied two ligatures and divided the tissues between He then permitted the two ends of the ligated tissues to retract and he sutured the wound He was later called to see the patient [illegible] he could not urinate. Catheterization proved of no avail The house staff could not introduce [illegible] catheter Examination revealed that instead of ligating the spermatic veins the surgeon had ligated and severed the penis. Burrows concludes this narrative by stating that [illegible] this case [illegible] almost too gross an error to be printed but "once [illegible] happened once [illegible] he thought [illegible] might happen again If such mishaps are recorded in modern times, how cautious must the surgeon be in approaching the intricate problems presented in surgery of the kidneys, ureter prostate, seminal vesicles, etc [illegible] or in operations on the female genital organs? Yes, of all operations performed, circumcision tops the list for poor technic. Whether in simple catheterization of the bladder or the repair of [illegible] difficult hypospadias, or [illegible] ruptured urethra, the removal of an obstructing median bar of the prostate or in renal surgery the simple dilatation of the cervix uteri or an extended hysterectomy all must be approached by the surgeon armed with sound surgical judgment, a full knowledge of the problems involved and he must be free, at all times, from overconfidence and of inflexible assurance of "superior" ability

CHAPTER 39

GYNECOLOGIC OPERATIONS

Anatomic Considerations. (Fig. 1905.) The pelvic outlet is closed by two muscles, the levator ani and coccygeus. The former together with the strong fascia covering its external and internal surfaces, are important constituents of the pelvic diaphragm. The levator ani supports and retains the abdominal and

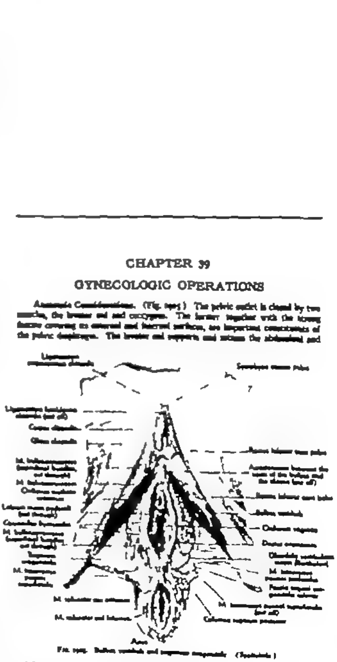


FIG. 1905. Bulbus vestibuli and [illegible] ([illegible])

pelvic viscera in their normal positions. It is [illegible] paired muscle taking origin from the tendinous arch and extends from the lower margin of the os pubis to the spine of the ischium, from the inner surface of the superior ramus of the os pubis and, from the pubes parallel to the symphysis, then from the pubococcygeus muscle. The pubococcygeus muscle is [illegible] smaller structure The relation of the levator ani to the external sphincter muscle of the rectum is of great importance. [illegible] perineal and deep pelvic fasciae also play an important [illegible] of the soft tissues comprising the pelvic floor (Figs. 1906-1907)

COLPOSCOPY

The colposcope devised by Harry O. Maryan[1] is used to magnify and detect lesions of the cervix uteri and the vaginal fornices, not visible to the naked eye.

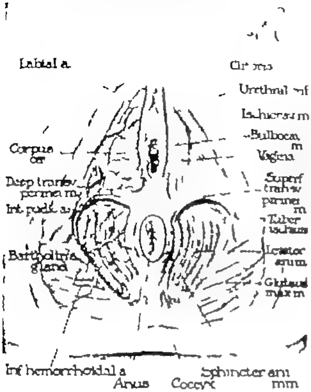


Fig. [illegible]. Anatomy of female perineum.

The colposcope is of especial value in detecting pin-point leukoplakias, precancerous lesions along the margins of erosions (the base of which is known as the matrix)

[1] Am. Jour. Obst. [illegible] Gynec., [illegible], July [illegible]

and also small early carcinomatous lesions. It also acquaints one with the surface of the erosion, the healed area of which is known as the transformation zone, and the granular red untreated area as the base or matrix. (Fig. [illegible])

Fig. [illegible]. Drawing of patient [illegible] gynecologic surgery. Note colposcope shaft permanently attached to the operating table.

The transformation zone and base of the erosion with its margins are the areas where leukoplakias and early carcinomas can be detected.

The colposcope may be used in conjunction with Schiller's test. With an ap-

plicator paint the cervix with Gram's solution, consisting of one part iodine to two parts of potassium iodide and 300 parts of water.

A positive Schiller's test is characterized by a definite area which does not take the stain. It was discovered by Lahm that the glycogen present in large *quantities in the normal epithelium of the portio vaginalis of the cervix disappears* with the change of the epithelium into carcinoma. After [illegible] few minutes the

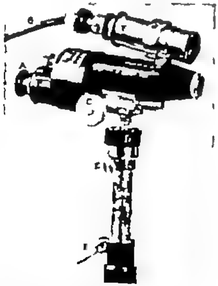


Fig. [illegible]. Maryan's colposcope. A, Eyepiece. B, [illegible]. [illegible] Clamp of diaphragm rod for telescope. F, lamp attachment [illegible]. H, [illegible] rod. [illegible] Clamp of stand.

Gram's solution fades away. Therefore one should make the observations immediately. Leukoplakias and early carcinomas do not take the stain and are brought out with the aid of the colposcope.

This colposcope is a monocular achromatic prismatic telescope giving magnifications of 6, 10, [illegible] and 30 diameters, at a focal distance of [illegible] inches from the cervix to the front lens. It gives an erect image and has a fixed focus. It can be used on a circuit of [illegible] to V. 60 Cy A.C. or D.C. current, as it contains a rheostatic cord attached to the lamp.

The magnification can be increased by interchanging the eyepieces as they are correctly marked. The free working distance from the cervix to the front

lens is 6½ inches. The distance from the eyepiece to the front lens is [illegible] inches, leaving adequate room to perform direct biopsies, electrical cauterization, or coagulation, and to perform any manipulation which may be necessary, including the Schiller's test. We have found for preliminary study that the six-power *magnification acquaints the observer with the general picture.* After this preliminary study the ten-power eyepiece is used to focus carefully the suspicious lesion or area. The ten-power magnification is universally accepted by most observers. The higher the magnification the greater is the distortion and the smaller becomes the visual field.

The next important step is to obtain adequate exposure and to have the field as dry as possible. For this, Maryan uses semi-inserted Graves' speculum and Gusberg's operative speculum. In this way unnecessary glare and reflections will be done away with, and will prevent fogging of the colposcopic picture. The vagina, fornices and the cervix should be carefully wiped clean with one per cent solution of lysol on cotton sponge and dried. The heavy mucoid discharge from the cervical canal may be dissolved with "cereal powder" on a cotton applicator. It may be necessary to repeat this procedure several times to secure a dry field and avoid the fogging of the colposcopic picture. The observer can now visualize through the colposcope the cervix, the fornices, and the cervical canal and detect conditions that he was not able to see with the naked eye.

Colposcopic findings should always be checked by multiple or serial tissue sections. In this manner mistaken cancer diagnoses will be greatly reduced.

OPERATIONS ON THE EXTERNAL GENITALIA

VAGINISMUS

Operation for vaginismus calls for (a) Excision of the hymen or (b) Enlargement of the vaginal entrance (Fenger's operation).

Step [illegible]. Small, sensitive hymenal carunculae myrtiformes about the introitus vaginae are excised and the entrance to the vagina thoroughly dilated. Check oozing by means of packs or sutures of catgut.

Step [illegible]. If the hymen is intact, excise its base of attachment around the introitus. Always remove the entire hymen. Stretch the introitus with the thumbs, introducing first one, then the other.

PERINEOPLASTY (PERINEORRHAPHY)

Local infiltration anesthesia may be used as depicted in Fig. [illegible], which depicts the rectal wheal of ½ per cent novocaine solution creating an area of blanching from one caruncula myrtiformis to the other. Figure [illegible] shows the method of outlining the lateral triangles to be denuded within the vagina while Fig. [illegible] depicts the completion of the denudation.

Step [illegible]. Planning the Flap. Study the direction and extent of the laceration. Find the caruncular myrtiformes on either side of the hymenal circle. Grasp them with [illegible] vulsellum forceps or tenaculum sutures; place another vulsellum at the highest point of the laceration—the "crown." (Fig. [illegible]). In placing the vulsella at the caruncular extremes their distance is related to the external urethral orifice in order to avoid the formation of too small an introitus.

Step [illegible] Opening the Pelvic Floor (Fig. [illegible]). Make a curved incision with its convexity upward extending from one caruncle (vulvar [illegible]) to its opposite fellow. Dissect or divide the vaginal mucous membrane for a short distance with a sharp scalpel, the cutting edge of which is directed toward the vagina in order to avoid injury to the underlying rectum. Extend the dissection upward to the [illegible] holding the crown—the highest point of the laceration. [illegible] the dissected flap of vaginal mucosa with scis-

Fig. [illegible]. [illegible]

sors. Once the line of cleavage between the vaginal wall and the underlying structures is entered the detachment of the vaginal flap proceeds with facility by continuing the dissection with a gauze covered right index finger. There is a layer of [illegible] between the rectum and the vaginal wall [illegible].

Step 3. Isolation of the Levator Ani Muscle Fascia ("[illegible]"). The anterior margin of each levator ani muscle is now located by palpation with the finger and detached [illegible] for about [illegible] cm. By [illegible] separating the vaginal flap laterally toward the pelvic floor the fascia and levator ani will be made more accessible (Fig. [illegible] b).

Step 4. Uniting the Levators and Fascia (Figs. [illegible] d). With catgut of sufficient tensile strength and durability (No. [illegible] chromic) carried on a curved Mayo needle, unite the levators and fascia by interrupted sutures [illegible]

Fig. [illegible]. Amputation of vaginal triangle.

Fig. [illegible]. Amputation completed.

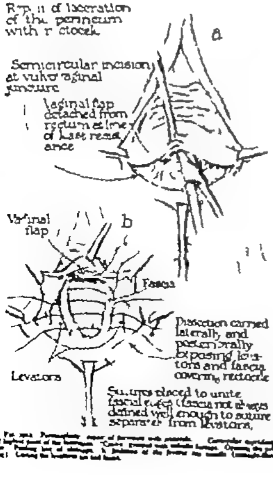


Fig. [illegible]. Perineorrhaphy: repair of laceration with rectocele. [illegible]

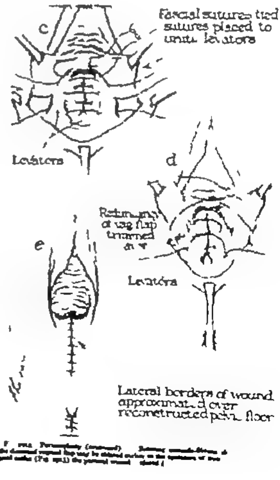


Fig. [illegible]. Perineorrhaphy (continued). [illegible]

such a manner that when the sutures are brought together and tied an outlet of proper proportions results. As many sutures as are necessary to thoroughly unite the structures should be used (about 3 or 4). Include in the upper sutures the connective tissues at the base of the vaginal flaps. Bleeding may now be encountered; arrest it now instead of waiting until later. Ascertain the size of the introitus by introducing three fingers into

At the conclusion of the operation it should admit two fingers easily (Fig. 1913). After the first suture is tied it is easy to ascertain the size of the introitus vaginae. If too large, take up the slack; if too small, readjust the sutures. We recall that a renowned French gynecologist was killed by the husband of a patient who believed that his wife's vagina was rendered too narrow following a perineal repair.

Step 3. Closing the Cutaneous Structures (Fig. 1912). This is accomplished with interrupted sutures of Pagenstecher linen.

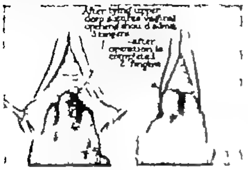


FIG. 1913. Perineorrhaphy. Method of testing the size of the vaginal opening after application of upper deep sutures and completion of the operation.

Comment. In cases where the separation of the vaginal flap from the adjacent structures is beset with difficulties denudation should be practiced. This consists in first outlining the area to be denuded with a scalpel and then snipping off the mucosa of the entire area embraced in the outlined region.

Complete Laceration of the Perineum

In cases of complete severance of the sphincter ani muscle, the ends retract gradually and after some time become widely separated. The muscle gradually becomes atrophic.

The two important factors from the standpoint of success in the repair of completely torn perineum are:

(a) To accomplish direct union of the divided ends of the sphincter muscles.

(b) To avoid the passage of sutures on the mucous surface of the bowel by turning down an apron of tissue from the torn septum.

Step 1. Stretching of the torn and separated sphincter muscle. The torn muscle is stretched with the fingers permitting the disabled sphincter to regain its function by operatively restoring its circular form. This can be accomplished with persistent and dextrous endeavor.

Step 2. Flap formation or Denudation. Figure 1914 a depicts the line and extent of the flap formation. A flap, fairly thick, to prevent ischemia and consequent sloughing, should be made. Note that after the denudation, an apron of tissue (A) and (B) is left which will be dissected free and turned down. After this has been done pick up the tissues in the sphincter pit; carefully dissect around the point elevated with tissue forceps (Fig. 1914 b) using pointed curved scissors for the dissection. First one, then the other side is dissected free and pulled out. The dissection of the apron coupled with the lateral incisions will usually effect the necessary exposure of the torn ends of the sphincter muscle.

Step 3. Suturing the Sphincter Ani. The approximated ends of the torn sphincter are united with 20-day fine, interrupted chromic catgut sutures (Fig. 1914 c). Splint the united sphincter muscle with silkworm-gut tension sutures passed as shown in Fig. 1914 d.

Step 4. Repair the pelvic floor as described above. The sides of the apron are united with Pagenstecher linen sutures. The formation of an apron was first suggested by C. Warren of Boston.

Comment. Control of the sphincter should not be expected promptly after the operation. It takes a number of weeks or even months before the tone of the sphincter is restored, depending upon the time elapsed since the injury was inflicted as well as the degree of damage done.

PROLAPSE OF THE URETHRA

Step 1. Grasp the anterior and posterior portions of the prolapsed mucosa with Allis forceps. Bring the mucosa completely down.

Step 2. Insert a trocar-pointed needle threaded with a No. chromic catgut (20-day) suture through the urethra above the prolapsed part. (Fig. 1915.)

Step 3. Ablate the projecting mucosa below the transfixion suture which is pulled out in a long loop as it crosses the urethral canal. It is then divided and each half tied and held. (Fig. 1915 b, c.)

Step 4. Unite the divided edges with a series of fine interrupted sutures to the skin of the vulvar vestibule. (Fig. 1915 d.) Insert a sound into the bladder to insure patency of the urethral passage.

Comment. If too wide an area of surrounding mucosa has been removed or the wound heals by secondary intention, stricture of the urethra may result. This is treated by urethral dilatation or by a plastic procedure which consists of dividing the constriction and suturing the raw area so that the opening is enlarged.

URETHRAL CARUNCLE

Step 1. Insert a sound into the bladder and dilate the urethra to about 12 Hegar. Cautiously pull the caruncle downwards. Insert a suture from side

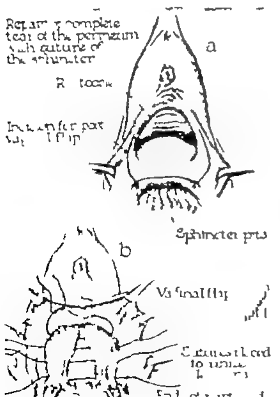


FIG. 1914. Repair of total perineal laceration. a, Incision, flap formation or denudation. b, Isolation of sphincter structures to be approximated. Dissection of sphincter pit and exposure of ends of ruptured sphincter ani.

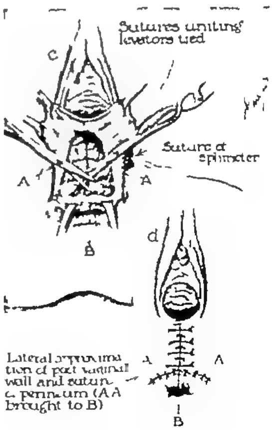


FIG. 1914 (continued). Repair of total perineal laceration. c, Suturing the torn ends of the sphincter ani and of the levators and fascia. d, Repair of the superficial perineal structures.

in skin through the floor of the urethra about one-quarter inch above the caruncle. This suture is used as traction suture to bring down the urethral [illegible] after the caruncle has been removed. (Fig. [illegible])

Step [illegible]. With forceps, elevate the caruncle. In so doing handle the delicate caruncular structure gently lest it tear off. Make an incision around the

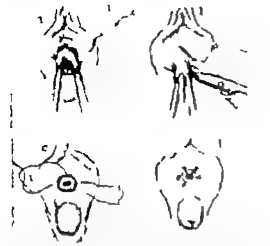


Fig. [illegible]. Operation for pedunculated urethra. [illegible]

base of the caruncle leaving narrow margin of mucous membrane between the cut edge and base which is undercut about one-eighth of an inch.

Step 3. Check bleeding with hot compresses.

Step 4. Start traction on the stitch through the floor of the urethra exposing the upper divided edge. Insert three or four interrupted catgut sutures to

Fig. [illegible]. [illegible]

Fig. [illegible]. Removal of Bartholin cyst. [illegible]

unite the edges and check oozing. Insert [illegible] into the bladder to insure patency of the urethral lumen.

Swab the parts with an antiseptic solution and apply an aseptic pad. Apply to the suture line a 5 per cent chloretone solution to relieve pain. Encourage the patient to empty the bladder naturally; catheterization may be necessary.

Comment: Urethral caruncles tend to recur frequently; this may be largely prevented by deep excision of the base of the growth. Difficulty is often experienced in approximating the upper and lower divided edges of the raw area because of the oozing. The [illegible] when used in place of scalpel checks the oozing.

CLITORIDECTOMY

This operation is indicated in carcinoma or hypertrophy of the clitoris.

Carcinoma not infrequently develops on the clitoris; the growth invades the labia majora and minora at an early stage. The treatment is radical operation which is similar to vulvectomy. The lymph nodes in both groins may be removed later or at the same time. The skin incisions are made wide of the involved area and the entire clitoris is removed down to the attachment of its crura to the pubic rami. Some cases of marked hypertrophy of the clitoris may cause dyspareunia, calling for operative removal.

Step 1. Make curved incision around the base of the clitoris. (Fig. [illegible])

Step [illegible]. Retract the lateral skin edges with Allis forceps; draw the clitoris upward and divide its base of attachment to the symphysis pubis with scalpel. (Fig. [illegible])

Step 3. Check bleeding of the dorsal vessels of the clitoris and its corpora cavernosa with properly placed catgut ligatures. (Fig. [illegible])

Step 4. Approximate the edges of the incision with interrupted silk or Pagenstecher linen sutures including the subcutaneous tissues. (Fig. [illegible])

VULVECTOMY

Indications: Carcinoma, tuberculosis, leukoplakic vulvitis, elephantiasis, hypertrophy and intractable pruritus.

Step 1. (Fig. [illegible]) Make an incision around the vaginal entrance and in front of the urethra. Make second incision starting above the glans clitoris, proceeding around the vulva including the labium majus on each side and the fourchette posteriorly. In carcinoma, leave wide margin of uninvolved skin between the growth and the divided border. (Fig. [illegible])

Step 2. Remove the tissues lying between the two incisions down to the deep fascia. (Fig. [illegible])

Step 3. Unite the cut edges around the vaginal entrance with interrupted sutures. Insert the first two stitches on each side uniting the skin to the cut edge surrounding the urethra; bring the skin edges in front of the urethra together from side to side. If difficulty is encountered in joining the outer skin edge with that around the vaginal entrance, mobilize it for about an inch. (Fig. [illegible]) Close the skin edges carefully. Remove the inguinal lymphnodes on both sides.

Step 4. Dress with dry gauze; apply T-bandage with bismuth ointment. Give morphine for two or three days following the operation to relieve pain.

Catheterization may be necessary. Where septic growth has been removed, insert an indwelling catheter into the bladder; leave it there for few days.

OPERATIONS ON BARTHOLIN'S GLANDS

Drainage of Bartholin abscess.
Excision (chronic suppuration, cyst, malignancy)

Drainage of Bartholin's Gland Abscess

While some contend complete removal of the Bartholin gland, in cases of acute suppuration, it is safer to drain the abscess first and remove the gland later if need be. Drainage alone will frequently not cure suppuration because the gland is of the compound racemose type. Infected small pus pockets the infection causing either recurrent abscesses or continuous discharge.

Step [illegible]. Make an incision over the most prominent portion of the swelling in the long axis of the labium majus at its junction with the vaginal mucous membrane. (Fig. [illegible])

Step [illegible]. Evacuate the pus; pack cavity with gauze saturated with glycerine.

Apply hot fomentations and repack the cavity daily until all symptoms disappear. Electrosurgical destruction of the lining of the sac may be done.

Excision of Bartholin's Gland

Step 1. Make double incision in the long axis of the labium majus extending the full length of the affected area including the sinus and narrow ellipse of skin.

Step 2. Retract the skin edges thoroughly while the indurated tissues are completely dissected. (Fig. [illegible])

Step 3. Check oozing, dry the wound and swab it with tincture of iodine. Insert small drainage-tube into the depths of the cavity which is obliterated with catgut. Approximate the skin edges with Pagenstecher linen or silk. (Fig. [illegible])

In cases of carcinoma of the Bartholin gland, thorough dissection of the affected gland as well as the lymph nodes draining it is essential.

Excision of Bartholin Cyst

Step [illegible]. Tense the skin over the cyst between the thumb and index finger of the left hand. Make an incision over the most prominent portion of the cyst.

Step [illegible]. Retract the edges of the wound and remove the cyst by means of sharp dissection.

Since the cyst is often fastened to the labium minus on the inner side, it is desirable to dissect the outer side and the deep aspect of the cyst first, bisecting the inner side last.

Step 3. Obliterate the resulting cavity from the bottom upwards, with interrupted sutures of fine catgut. Close the skin with Pagenstecher linen.

OPERATIONS ON THE VAGINA

ATRESIA OF THE VAGINA

There are two varieties of vaginal atresia (a) congenital and (b) acquired. Congenital atresia occurs more [illegible] variety. It is

caused by the partial coalescence of the vaginal cords which project downwards from the Müllerian ducts. As a result of the atresia, hematometra, hematocolpos and hematosalpinx may eventuate. Coition is, of course, impossible.

Treatment

Divide the septum and evacuate the thick, black fluid contents of the vagina. Observe rigid asepsis. Infection may end fatally. This is especially true in the

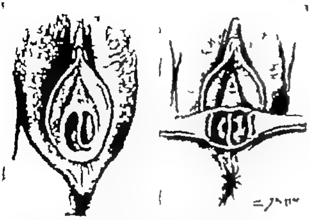


Fig. 1919 Fig. 1920

Fig. 1919. Double uterus with double (septate) vagina. [illegible]

Fig. 1920. Double uterus with double (septate) vagina. [illegible]

presence of hematometra (distention of the uterus with menstrual blood) and hematocolpos (distention of the vagina).

Comment. Imperforate hymen is sometimes encountered. The symptoms are the same as those of complete atresia. Acquired atresia is very similar in characteristics to the congenital type.

SEPTATE VAGINA

If the two divergencies from the Müllerian ducts fail to fuse completely the result is a septate vagina. One part may be smaller than the other and thus escape notice. In the case of a double uterus (Figs. 1919-1920-1921) both parts of which are sufficiently developed, the two sides may function during parturition. Occlusion of one side of the lower end may persist, causing hematocolpos, hematometra or even hematosalpinx on the involved side.

In case of dyspareunia, the septum must be excised. Treatment for the retention of secretion in the obstructed portion of the vagina is the same as for atresia.

ABSENCE OF THE VAGINA

Construction of a Vagina by Transplantation of a Loop of Intestine

BALDWIN'S OPERATION

Historical Notes. In 1907 Baldwin devised a method which gives a permanently useful vagina. It consists of using a loop of small intestine for the formation of the vagina. This operation has now been used successfully in a number of cases and by different surgeons and has proved exceedingly satisfactory. It is carried out as follows.

Step 1. Place the patient in the lithotomy position after preparation is made for both perineal and abdominal operation. Make a transverse incision where the vaginal opening should be, between the urethral orifice and the

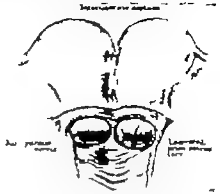


Fig. 1921. Double uterus with single vagina. [illegible]

rectum. Dissect carefully bluntly from this incision between the bladder and rectum up to the peritoneum. Be careful not to enter the bladder or rectum. Widen the space in all directions, press a long artery forceps against the peritoneum which is still unopened and pack the canal thus made with gauze, about the forceps. (Fig. 1922[1])

Step 2. Place the patient in the horizontal position and make a median incision in the abdomen. (Fig. 1922[2-3-4]) Select a loop of ileum about a foot long for making the vagina. The loop must be long enough so as to be drawn into the connective tissue canal already made, without undue tension. A loop ending four or five inches from the ileocecal valve is satisfactory. Press the intestinal contents out of the loop and resect it, being careful to preserve the mesentery. The continuity of the bowel is restored by means of a Murphy button. Invert the ends of the resected loop with purse-string sutures.

Step 3. The peritoneum over the point of the forceps in the vagina is opened and the opening enlarged to permit the loop of resected intestine to be drawn [illegible] possible.

Baldwin's Operation for Artificial Vagina

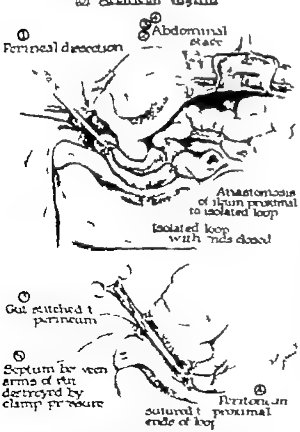


Fig. 1922. Baldwin operation for making an artificial vagina. [illegible]

through. An assistant grasps the middle of the loop of intestine, drawing it into the newly made canal between the bladder and rectum.

Step 4. Close the peritoneum over the ends of the loop. Do not constrict the mesentery.

Step 5. Close the abdomen.

Step 6. Place the patient in the lithotomy position. Open the loop of bowel where it is caught with the forceps and suture the opening all around to the skin margin. (Fig. 1922 [5])

Step 7. Clean the loop of all mucus and lightly pack it with gauze to press the peritoneal surface of the bowel against the surrounding raw surfaces so that union will readily take place.

Comment. When the patient is fully recovered, divide the septum between the two arms of the loop by means of pressure necrosis. Introduce a long clamp, one blade in the upper and one in the lower arm of the loop. Close the clamp firmly and leave in place until it cuts through; this takes about five days. A colostomy may be required.

Baldwin comments: "While studying the technic of this operation from a theoretical point of view I took pains to examine the ileum and sigmoid in a large number of patients on whom I was making ordinary abdominal operations. Several hundred patients were thus examined and in all I found that there would be no difficulty in drawing down such a loop of ileum into the vagina or a loop of sigmoid if for any reason the ileum should not be found satisfactory. With either there would be plenty of slack of the mesentery so that the circulation would not be interfered with. I have always used, however, a loop of ileum, because sanction of the ileum is safer than resection of the sigmoid. In all of my cases operative recovery was absolutely smooth and the new vagina seems to take the place very satisfactorily of the natural organ. I was induced to use the bowel for this purpose because after a very extended study of the vagina, other methods resulted in almost complete failure, although full of promise in many cases when the patient left the operating table. The favorite method of operating had been by transplantation of pieces of skin, to line the artificial canal. In all of these cases, however, to which I had access, the ultimate results had been very unsatisfactory owing to cicatricial contraction. By the use of the bowel a normal mucous membrane is provided, surrounded by normal connective and muscular tissue and with an ample blood supply. Theoretically and practically, therefore, such a vagina would seem to fulfil to the highest degree all the requirements.

"The dangers of operation are simply those inherent in any other abdominal resection and anastomosis of intestines, but the operation is one which should certainly not be undertaken by a tyro in surgery. My first operation took over two hours, the last one about half that time, and I should be not unacquainted that the operation should be done in one hour. There is, of course, no hemorrhage to amount to anything and if the field of operation is carefully protected there should be no shock. The danger, therefore, would be mainly the danger of a possible infection from the intestine, and that danger in the hands of an expert is very slight. Never-

[illegible], the danger should be fully explained to the patient, who would then decide whether the operation would be worth while.

GENITAL FISTULAS

The principal varieties of these are the following: ( ) vesico-vaginal, (b) vesico-utero-vaginal, (c) urethro-vaginal, (d) recto-vaginal and ( ) [illegible] fistulas.

Historical Notes. [illegible] (18[illegible]) made [illegible] thorough study of the history of the development of the operative procedure of this distressing condition. [illegible] plan of treatment (closure by [illegible]) [illegible] Roonhuysen of Amsterdam [illegible] exposed the fistula through [illegible] speculum, pared its edges and united them by [illegible] needle. [illegible] of Würzburg [illegible] catheter. [illegible] used the [illegible] position and employed [illegible] suture [illegible]. A vaginal plug and catheter in the bladder were used by [illegible]. [illegible] of Würzburg [illegible] scarified the edges of the fistula with scissors, approximated them with needles and interrupted sutures. Schreger (Germany) in 1[illegible] placed the patient on the abdomen, scarified the edges of the fistula and united them with interrupted sutures. In 18[illegible] Lallemand (France) applied silver nitrate to the edges of the fistula and approximated them by [illegible] introduced through the bladder. [illegible] of fibers were cured by this method. In 18[illegible] (France) used [illegible] sutures, metallic [illegible] and ordinary thread. In 18[illegible] of London used the knee-elbow position, [illegible] speculum, metallic sutures and [illegible] permanent catheter in the bladder. A clamp suture was used by [illegible] in 18[illegible]. Jobert de Lamballe in 18[illegible] used autoplasty by transplanting [illegible] piece of labia or tissue from the thigh or buttocks to cover the defect. [illegible] (18[illegible]) placed his patients on the abdomen, [illegible] the edges of the fistula and approximated them with small needles and figure-of-eight sutures. [illegible] in 18[illegible], [illegible] and [illegible] of [illegible] made advances in operations for vesico-vaginal fistula, the latter being particularly successful. In 18[illegible] Jobert de Lamballe used [illegible] method which he called "[illegible]", which consists of [illegible]. In 18[illegible] Marion Sims (America) achieved much success by the combined use of speculum, suture and catheter. He claimed credit for the following: ( ) [illegible] method for the dilatation and exploration of the vagina. (II) [illegible] suture not liable to cause inflammation and ulceration. ( ) [illegible] method of keeping the bladder empty during the process of cure. [illegible] (Germany) did much in systematizing the operation.

Vesicovaginal Fistula

For types of fistula, see Fig. [illegible].

Instruments. [illegible] speculum, lateral retractors, tissue forceps, [illegible] fistula scissors, needles, needle holder and suture material (fine silkworm-gut, silk, catgut).

METHOD A. DENUDATION PROCEDURE [illegible]

Step [illegible]. Expose the vaginal wall and expose the fistula, and the exposure by [illegible] the cervix [illegible] volsellum forceps and pulling it down.

Step 2. Freshen the edges of the fistula with [illegible] special scissors designed for the purpose or with [illegible] scalpel. Trim the tissues down to but not into the vesical mucous membrane and extend the denudation outward into healthy tissue (Fig. [illegible]).

Step 3. The sutures (fine silkworm-gut or chromic catgut) are placed as outlined in the illustration. (Fig. [illegible]) The needle enters the vaginal mucosa about [illegible] mm. from the margin of the denuded area emerging just

under the vesical mucosa. It is made to re-enter the opposite side and to emerge on the vaginal surface at [illegible] point corresponding to [illegible] opposite fellow. The other sutures are placed similarly and about one-half [illegible] cm.

Fig. [illegible]. Different types of genital fistulas. [illegible]

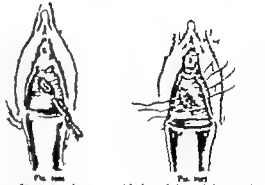


Fig. [illegible] Fig. [illegible]

Fig. [illegible]. [illegible] operation for vesicovaginal fistula. [illegible]

[illegible] apart. The defect is closed by as many sutures as are deemed necessary. Approximate snugly but do not strangulate the tissues as shown by blanching of the mucous membrane.

Step 4. Introduce [illegible] catheter for [illegible] few days.

METHOD [illegible]. [illegible] OF THE BLADDER WALL

A. Mackenrodt (18[illegible]) popularized this method [illegible] is an excellent procedure.

Step [illegible]. Expose the fistula as at the previous procedure.

Step 2. Make an incision about the median line, across the fistula, through the vaginal wall down to the bladder exposing the entire vesical base, as in operations for [illegible] cystocele. (Fig. [illegible])

Step 3. Split the edges of the fistula and dissect the bladder freely from its surroundings on all sides. (Figs. [illegible])

Step 4. Close the opening in the loosened bladder by suturing its raw edges together with [illegible] fine continuous chromic catgut suture. As many rows of sutures as are deemed advisable are introduced (usually 2-3) to accomplish broad surface approximation. (Figs. [illegible])

Step 5. Close the wound in the vagina. Let the line of sutures come to lie as distant from the suture line in the bladder as possible. (Fig. [illegible]) [illegible] catheters in situ for three days to relieve the bladder and encourage prompt healing.

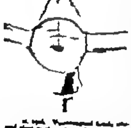


Fig. [illegible]. Vesicovaginal fistula [illegible] to the cervix. Dotted line [illegible].

METHOD C. [illegible] VAGINAL [illegible]

In cases of fistula resulting from accidental opening of the bladder during hysterectomy the operation consists of the following steps:

Step 1. Dissect the scar in the back of the fistulous opening at the vault of the vagina, cautiously. Avoid injury to the rectum by placing the finger in the rectum during the dissection.

Step 2. Incise and enter the peritoneal cavity. Enlarge the opening by introducing the index fingers and spreading them laterally.

Step 3. Pull the fistula down into the vagina, dissect it out and freshen its edges.

Step 4. Close the fistula with one or two layers of fine chromic catgut sutures.

Step 5. Close the peritoneum partially. Insert [illegible] cigarette drain for [illegible] day or two.

METHOD [illegible]. CLOSING THE FISTULA THROUGH THE BLADDER

Occasionally it seems desirable to close [illegible] fistulous tract by entering the bladder suprapubically (extraperitoneally); the margins of the fistula are denuded and sutured. If the fistula is inaccessible the peritoneum may be entered, the bladder pulled up and detached from the uterus, and if necessary from the vagina. The fistula is exposed, its margins freshened and sutured with catgut sutures. The peritoneum may be drained through the vagina.

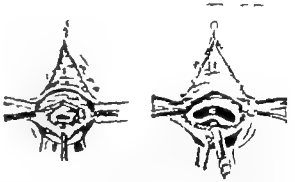


Fig. [illegible] Fig. [illegible]

Fig. [illegible]. [illegible] fistula situated close to the cervix [illegible].

Fig. [illegible]. [illegible] fistula situated close to the cervix [illegible] bladder from the cervix [illegible].

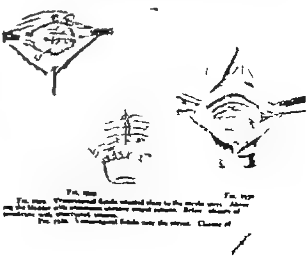


Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Vesicovaginal fistula situated close to the [illegible]. [illegible] the bladder with [illegible] catgut sutures. [illegible]

Fig. [illegible]. Vesicovaginal fistula near the cervix. Closure of [illegible]

Fig. 1931 [illegible] Fig. 1932

Fig. 1931. Repair of [illegible] fistula. Dotted line indicates the course of the incision for [illegible] the [illegible] flaps. The [illegible] appears below the fistula. [illegible]

Fig. 1932. Repair of [illegible] fistula. A finger introduced into the vagina presses the rectal wall [illegible] and brings the fistulous opening up to the [illegible] [illegible] shown in the illustration.

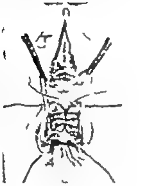


Fig. 1933 [illegible] Fig. 1934

Fig. 1933. Repair of [illegible] fistula. The fistula [illegible] along the [illegible] of the posterior vaginal wall. The dotted lines indicate the [illegible] of vaginal [illegible] between the [illegible] and vagina to be [illegible].

Fig. 1934. Repair of [illegible] fistula. The levator ani muscle has been [illegible] beneath the vaginal flaps with interrupted catgut sutures. [illegible] the placement of the sutures.

METHOD [illegible] RECTOVAGINAL FISTULA

Figures 1931-1932-1933-1934-1935 depict the steps of the operation

METHOD [illegible] [illegible]

Von Rosthorn's operation. The body of uterus is brought down into the vagina as in Watkin's interposition operation for prolapse (which see); the margin of the large fistula is freshened and sutured to the posterior wall of the uterus.

[illegible] COLLINS' TECHNIC FOR THE REPAIR OF VESICOVAGINAL FISTULAE

Comment: This is [illegible] modification of C. H. Mayo's operation.

Step 1. A large vulvar dilator is used such as that of J. F. Percy. If necessary Schuchardt incision may be made in the side of the vulva.

Step 2. Make [illegible] transverse incision in the vaginal mucous membrane. Make an elliptical incision running transversely around the edge of the fistula. Collins believes that the direction of the incision is of little importance whether it be transverse, longitudinal or crucial.

Step 3. Pass [illegible] curved sound or forceps into the bladder through the urethra. An effort should be made to determine the thickness of the partition between the bladder and vagina. The vaginal flaps should be as thin as possible so as to leave the greater thickness of the partition on the bladder wall.

Step 4. Separate the vaginal flaps from the bladder as far as possible in order to expose and mobilize the bladder.

Step 5. The problem here is to get the fistulous opening to project into the vagina as far as possible, to facilitate the placing of the sutures.

Fig. 1935. Repair of [illegible] vaginal fistula. The [illegible] shows placement of sutures closing the [illegible] [illegible] [illegible] [illegible] gut or [illegible] silk.

Step 6. A needle threaded with catgut is passed through the edges of the fistula. Traction on that brings [illegible] cone-shaped portion of the bladder into the vagina with the fistula on the apex of the cone (Fig. 1936).

Step 7. Pass one or more purse-string sutures around the cone thus produced.

Step 8. Pass [illegible] curved forceps through the urethra and on through into the vagina.

Step 9. Grasp the ends of the suture through the edge of the fistula by means of the forceps and draw it up into the bladder and out through the urethra (Fig. 1937). Traction on this suture produces [illegible] cone with the fistula on the apex.

Step 10. Tie the purse-string sutures in the vagina firmly. This will fix the cone and bring the raw under surfaces of the bladder together. If the fistulous opening is rectangular instead of round, use continuous suture. [illegible] Jour of Surg, Gyn and Obs, [illegible], [illegible]

These push the edge of the fistula up into the bladder. After the fistula is closed, [illegible] few interrupted sutures may be passed in the bladder wall to support the sutures already placed.

Step 11. Bring the base of the vaginal flaps together with mattress sutures so as to push the edges of the flaps down into the vagina, the object being to get the external opening of the fistula as far from the internal opening as possible.

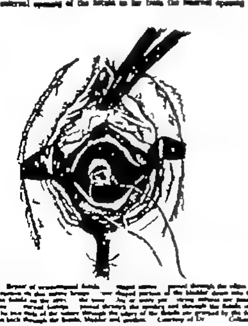


Fig. 1936. Repair of vesicovaginal fistula. [illegible] passed through the edges of the fistula. [illegible] brings [illegible] cone-shaped portion of the bladder down into the vagina with the fistula on the apex [illegible] [illegible] [illegible] sutures are passed around the cone [illegible] curved forceps [illegible] passed through the urethra and through the fistula into the vagina. The two ends of the suture through the edges of the fistula are grasped by the forceps and drawn back through the fistula, bladder and urethra. Courtesy of Dr [illegible] Collins.

Comment: The sutures closing the fistula should not be tied too snugly or they will defeat the purpose for which they are used. Approximation and not strangulation should be the rule. The suture material should be chromic or tanned catgut. Perfect hemostasis is essential. Nonabsorbable sutures may be used. A self-retaining catheter should remain in the bladder for about 12 days. The bladder should be irrigated twice [illegible] day with some bland solution such as boric acid. Only one or two ounces should be used at a time in irrigating the bladder. The patient should be encouraged to lie on [illegible] abdomen as much as possible. Some patients do this with ease; in [illegible] it causes great discomfort.

Where failure threatens, the introduction of several catheters and allowing them to remain about two weeks or until they cause irritation is [illegible] good plan to follow. It has been successful when other methods failed.

Vesicocervicovaginal Fistula

HOWARD KELLY'S PROCEDURE

Step 1. Engage the cervix in [illegible] volsellum forceps and pull it down. Detach the vaginal vault from the front, dissecting well above the point of the fistula.

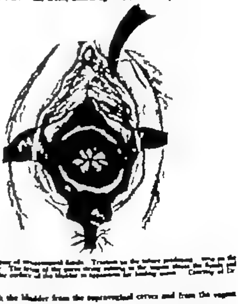


Fig. 1937. Repair of vesicovaginal fistula. Traction on the suture produces [illegible] cone on the [illegible] of the bladder. The tying of the purse-string sutures in the vagina [illegible] the fistula and brings the raw under surfaces of the bladder in apposition for healing [illegible]. Courtesy of Dr [illegible] Collins.)

Step [illegible] Detach the bladder from the supravaginal cervix and from the vagina on all sides.

Step 3. Closure is effected by fine interrupted sutures of horse hair, silk or chromic catgut, the bladder wall being united with two or three layers of sutures.

Step 4. The cervix may or may not be reattached with two or three chromic catgut sutures at the vault of the vagina.

[illegible] MODIFICATION OF KELLY'S OPERATION FOR [illegible] [illegible]

Vincent J [illegible] O'Conor modified the Kelly procedure as follows

Step 1. Spinal Anesthesia. Lithotomy position with hips elevated by [illegible] wide sand bag

Step 2. Retract the posterior vaginal wall. Engage the posterior lip of the cervix with a vulsellum forceps and exert traction upon it downward and forward to bring the vesicovaginal septum into good view.

Step 3. (Fig. 1938) Introduce a straight Young prostatic tractor into the bladder; open its blades and pull them out in such a manner that they impinge upon the vesical outlet. The tractor pushes the base of the bladder downward and forward. This maneuver is more easily accomplished by the prostatic tractor than by pulling the tissues with tenacula or forceps from below—thus obviating injury to the tissues when pulled upon. The position

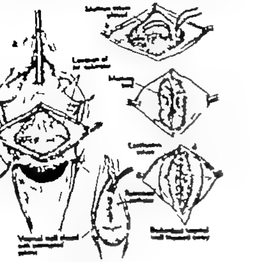


Fig. 1938. O'Conor modification of Kelly operation for incontinence of urine in women.

of the blades of the tractor affords an easy method of determining the exact location of the sphincter vesicae and facilitates the proper introduction of the overlapping sutures to be described.

Step 4. Incise the anterior vaginal wall for about 5 cm. in such a position that the neck of the bladder occupies the center of the incision. Dissect the flaps carefully, meticulously avoiding opening the urethra or bladder. This can be easily accomplished by carefully noting (palpating) the position of the tractor. Flaps of vaginal mucosa are widely detached on both sides by gauze dissection thus exposing the neck of the bladder and upper half of the urethra. By carefully adhering to the line of cleavage little bleeding is encountered. The detachment is carried farthest along the palpable blades of the tractor which outline the neck of the bladder.

Step 5. Introduce three mattress sutures of No. chromic catgut, gathering up the relaxed tissues adjacent to the tractor blades bring the sutures together (Fig. 1938 b). Pressure on the tractor from above presently greatly aids in the ease of application of these sutures.

Step 6. The tractor is removed before the sutures are tied (Fig. 1938). The fascial tissues on either side of the urethra are then brought together by two mattress sutures or continuous suture of the same material. This fortifies the posterior urethral wall (Fig. 1938 d).

Step 7. Trim away the redundant vaginal wall on either side and unite its edges with interrupted, fine chromic catgut sutures.

Step 8. Introduce a small special de Pezzer with a stylet in the catheter into the bladder which is kept in situ for about a week, thus affording rest to the bladder by keeping it empty.

Comment. The hips of the patient are kept elevated until the effects of the anesthetic have subsided (about two hours). O'Conor's modification of the Kelly procedure consists mainly in substituting a prostatic tractor instead of a sound or catheter as a guide; and the elimination of sharp instruments, thus avoiding trauma and affording better exposure; and the use of an indwelling catheter following the operation. The results of the operation are gratifying; patients pass their urine normally following the removal of the catheter.

Vesicouterine and Enterovesical Fistulas

These are treated by meticulous separation of the organs concerned, isolating and freshening the openings in the respective viscera, and their careful closure by appropriate sutures.

CYSTOCELE

Hadra (1889) and Kanger (1896) did pioneer work in this operation.

Step 1. Incision through the anterior vaginal wall. Steady the vaginal wall with two vulsella forceps, the latter just in front of the cervix. Outline the area to be denuded. An incision is carried from the introitus vaginae backward to the cervix uteri.

Step 2. Flap formation. The flaps are dissected free with a knife or scalpel (Fig. 1939) for a short distance, to be continued by dissection with the gauze-covered index finger. Keep close to the vaginal flap thus avoiding injury to the fascia attached to the bladder. When sufficient separation has been accomplished, remove the excess of vaginal wall with scissors.

Step 3. Transverse plication of the vesico-pubic plane (Fig. 1939 b,). Chromic catgut on a curved needle is used to accomplish this step. Two or three rows of sutures are used depending upon the depth of the prolapse of the bladder wall. No bulge should be visible after this step of the operation is concluded.

When the denuded flap of vaginal mucosa [illegible] trimmed off and the edges sutured by [illegible] [illegible] colporrhaphy [illegible] bladder [illegible] (anterior colporrhaphy), or to the rectal side (posterior colporrhaphy).

Fig. 1939. Operation for cystocele. Incision and flap formation. Suturing of the deep structures (imbricating the vesico-pubic plane). Closure of the vaginal wound.

Step 4. Closure of the vaginal wound. Interrupted or continuous Pagenstecher or 20-day catgut sutures are used to accurately approximate the free edges of the vaginal wall. Hemostasis.

OPERATIONS ON THE CERVIX

DILATATION OF THE CERVIX

Step 1. Retract the perineum by means of an Auvard speculum. Draw the anterior lip of the cervix downward by means of a vulsellum forceps.

Step 2. Wipe dry the external os and the cervix with cotton pledgets. Paint with iodine.

Step 3. Introduce a uterine sound. The direction and deviation of the canal is usually ascertained by sounding in various directions. In case of retroversion the concavity of the bend in the sound is directed backward and in anteflexion forward; the former is the most common.

Step 4. Ascertain the length of the uterus, the presence of submucous fibroid, septum or bicornuate uterus, etc.

Step 5. Dilate the cervix with Hegar's dilators dipped in glycerin until the desired size is reached (about to 14 Hegar). Make countertraction with the vulsellum on the engaged cervical lip while the dilators are being inserted.

The Dangers Connected with Cervical Dilatation Are: (a) Cervical lacerations; (b) perforation of the uterus.

The former is likely to take place when the cervix is dilated too rapidly or excessively, particularly in the presence of inflammation or in an infantile cervix. Lacerations usually occur in the region of the internal os; suspect it if the dilator suddenly slips forward where it hitherto resisted, if the succeeding dilators seem to enter too easily or if the grip on the dilator by the cervix is lost.

Perforation of the uterus may take place where the uterus is acutely anteor retroflexed, in which case the dilator penetrates the anterior or posterior uterine wall.

TRACHELOPLASTY OR TRACHELORRHAPHY

Step 1. The patient is placed in the lithotomy position. The external genitalia and vagina should be thoroughly prepared. Grasp the anterior lip of the cervix with a vulsellum forceps and steady. Dilate the cervical canal thoroughly with Hegar's graded dilators. Curet the uterus; paint its interior with iodine carried on long uterine applicators. Grasp the posterior lip of the cervix with a vulsellum forceps and approximate the edges of the cervical lips. Estimate the extent of the lacerations and decide whether simple trachelorrhaphy will suffice or an amputation of the cervix seems preferable.

Step 2. (Fig. 1940) Outline with a sharp scalpel the edges of the lacerations of the mucous membrane of the cervical canal and the areas to be denuded, leaving in the center of each lip a strip about a third of an inch in width to form the new cervical canal. Denude as shown in the illustration (Fig. 1940 b). If Nabothian cysts abound, it is better to do a partial or Sturmdorf conical

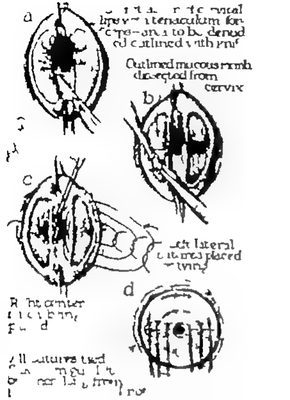


Fig. [illegible] Steps of [illegible] of cervix [illegible] Outline [illegible] area to be denuded. b. Method of denudation [illegible] Manner of introduction and placement of sutures [illegible] Completion of operation

Step 3. Introduction of the sutures takes place after denudation is complete and after cleansing the operative area. The first suture is introduced just below the angle of the incisions beginning on the vaginal mucous membrane of the cervix extending through the muscular tissue and emerging just at the edge of the mucous membrane of the cervical canal and then through the edge of the mucous membrane of the canal on the opposite lip, through the muscular tissue and emerging on the vaginal mucous membrane of the cervix opposite the point of introduction of the needle (Fig. [illegible])

Introduce as many additional sutures, about one-eighth of an inch apart, as are necessary to neatly complete the suture line until the [illegible] is reached. The sutures on the opposite side of the cervix are introduced in a similar manner. Special cervical needles, and silkworm gut or 20-day chromic catgut are used in the operation. the former are tied long, the latter cut short. The sutures should not be tied too snugly to avoid strangulation (Fig. [illegible] d)

Step 4. Pass [illegible] sound through the cervical canal to assure patency. Remove the retractors. Replace the uterus. Pack the vagina lightly (Iodoform gauze)

Comment. If nonabsorbable sutures are used remove them after [illegible] to 3 weeks. If the cervix is long, the inflammation marked or the laceration stellate or markedly irregular

Sturmdorf Operation

is to be preferred. This operation consists of [illegible] conical excision of the cervix. This procedure does away with the cystic areas in the cervix and the Sturmdorf stitch draws the vaginal mucosa over the raw surfaces and covers them in a highly satisfactory manner. The important features to be observed here are

Proper conization of the cervical tissue to be removed
Thorough hemostasis during the operation
3. Adequate covering of raw surfaces with the Sturmdorf stitch
4. Measures to avoid subsequent stenosis of the os

Step [illegible] Outline the area to be excised with [illegible] sharp scalpel (Fig. [illegible]) Avoid too much tissue sacrifice. No more cervical tissue should be removed than is necessary to insure the removal of the chronic inflammatory [illegible] (W. S. Cramer) Excise the deeper portion of the cervical cone with sharp, curved, pointed scissors

Step 2. A large, raw bleeding surface results. Grasp the spurting points with pointed artery forceps (Kelly or Ochsner type). These are left in situ for [illegible] minutes or two, and the bleeding stopped either by torsion or hot packs applied to the raw surface

Step 3. The Sturmdorf stitch is next introduced and tied on the anterior surface of the cervix (Figs. [illegible] b, c, d) Follow this by [illegible] similar suture below, after first releasing the artery forceps which were permitted to remain in the lower segment of the cervix while the upper suture was being introduced (Fig. [illegible]) Lateral sutures of catgut are next introduced (Fig. [illegible] f and g) on both sides. A catheter is introduced into the lumen of the cervico-uterine passage and retained in place during the time of healing. This is to

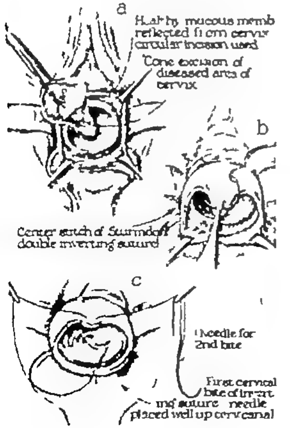


Fig. [illegible] Sturmdorf operation. [illegible] Cone excision of affected area. b. Method of placing Sturmdorf stitch in the upper part.

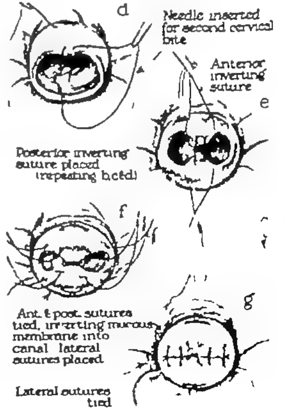


Fig. [illegible] (continued) Sturmdorf operation. d. Completing anterior Sturmdorf suture. [illegible] and [illegible] by placing similar stitch below. [illegible] lateral sutures on both sides. [illegible] Operation completed.

avoid stricture formation. Place a light iodoform tampon in the vagina. Dress.

TREATMENT OF CHRONIC CERVICITIS BY ELECTROSURGERY

Chronic cervicitis is one of the most frequent gynecologic disorders and has long been one of the hardest to cure. The treatment has gone through many phases since Emmet's first report in 1862 on lacerations and their surgical repair. The treatment of chronic cervicitis depends upon the proper selection of cases, and the proper understanding of the histopathology. Medicinal therapy is limited in scope and is rather unsatisfactory. H. O. Maryan[1] advocates treating chronic cervicitis by electrocoagulation. He prefers the crucial incision or striping method.

The terms erosion, ulceration or endocervicitis are a bit confusing, but easily understood if the process of chronic cervicitis is understood. Normally the vaginal portion of the cervix (the portio vaginalis) is covered by stratified squamous epithelium and contains no glands, while the cervical canal or endocervix is lined by high cylindrical compound racemose glands which are 3 to 4 mm. deep, and extend from the external os to the internal os, just below the isthmus of the uterus. Just within the external os, where the squamous epithelium meets the cylindrical epithelium of the compound racemose glands there is a definite line of demarcation.

The cervix is prone to infection because of its situation in the vagina, and because it is lacerated during labor. Crypts and lacerations of the mucous membrane afford protection for the invading organisms and in these crypts the gonococcus and other bacteria may be dormant for long periods of time.

It is accepted among gynecologists that chronic cervicitis is due to a persistent deep infection of the compound racemose glands (extending from the external os to the internal os) and which is characterized by periglandular and perivascular lymphocytic infiltration and a downward proliferation to the stroma and to the cervical lips of the compound racemose glands. This extension of the proliferation is referred to as the ectropion or an eversion, which is a misnomer. Maryan believes that with its associated inflammation and suppuration it should be called chronic panacervicitis or chronic cervicitis because the entire cervix is involved. Our understanding of the pathologic process of chronic cervicitis will help to differentiate between apparently normal and diseased tissue and to treat cervical lesions adequately. Macroscopically an erosion or chronic cervicitis is evidenced by redness of varying degrees of the cervical lips surrounding the patulous external os, together with an abundance of mucopurulent secretion from the cervical canal.

The treatment required for chronic cervicitis varies with the extent of the lesion. Treatment depends upon the location of the cervical lips. If the extent of the lesion extends about one-third the radius of the external os, or if there exists a slight eversion, a mild tear or incipient bulging of the Nabothian cysts, we recognize a mild type of cervicitis. If the lesion extends to two-thirds of the cervical lips we are confronted with a moderately advanced type of cervicitis, and if the lesion extends throughout both lips an advanced type of cervicitis is at hand. In this last class may also be included the hypertrophic bilaterally

lacerated cervicitides and the large smooth boggy incompletely healed form of cervicitis. The first two types are amenable to ambulatory treatment. The third class of cases is surgical. Other lesions of the cervix should be ruled out before coagulation is resorted to (syphilis, tuberculosis, early carcinoma and glandular leukoplakia). Because of the rich supply of lymphatics capable of producing such associated lesions as metritis, parametritis, and sacrouterine cellulitis, it is advisable to rule out chronic pelvic inflammatory residual pathology. Coagulation of the cervix should never be done in the presence of an acute or subacute inflammatory lesion of the internal or external generative organs. If the paracervical tissues are tender (digital examination per rectum) or if the uterus is retroverted, or if the sacro-uterine ligaments are tender or boggy, coagulation or cauterization should never be done.

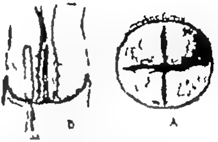


FIG. 1922. Electrosurgical treatment of infections of the cervix. A. Linear cruciate incisions with extension of the cervical canal. B. The tip of the spatula in use. ... Courtesy, Dr. H. O. Maryan.)

Rectal examination is indispensable in selecting cases for this form of treatment (Maryan). Smears give valuable information as to the type of bacterial flora, and rule out the hemolytic streptococcus of the apparently innocent case.

Where the cervix has an edematous and acutely inflamed appearance associated with marked leucorrhea, it is best to treat it first by topical applications of 10 per cent tannic acid and glycerin into the cervical canal, supplemented by daily hot douches. This will shrink the cervix materially and reduce the activity of the chronic inflammatory disease.

Step 1. Place the patient in the lithotomy position. Introduce a vaginal speculum. Dissolve the heavy mucoid discharge from the cervix with cereal powder. Usually no local anesthesia is necessary. If desired, however, one can use 15 per cent cocaine or a crystal of cocaine introduced into the cervix. A vulsellum is not necessary to hold the cervix in place if proper exposure is obtained with the ordinary vaginal speculum or Graves' operative speculum.

Step 2. Bipolar desiccation coagulation is used with the indifferent tin plate electrode under the sacrum and buttocks of the patient. The spatula tip

(5 mm. long by 3 mm. wide) needle electrode is used for coagulation of the cervix. The proper dosage is dependent upon the type of high frequency desiccating apparatus used. Routinely the conical cruciate incision or linear striping is used at 12, 3, 6 and 9 o'clock (Fig. 1922 A) commencing on the outer margin of the upper cervical lip at 12 o'clock, and extending to the external os. This is then repeated at 9 o'clock, 6 o'clock and at 3 o'clock, either in one sitting or preferably in four separate sittings, which may be done every other day. In this way the cervical canal is laid wide open and one can visualize the extent of the pathology and also carry on linear coagulation of the cervical canal. The linear or vertical striping of the cervical canal commences at right angles from the cruciate incisions at the external os and extends to just beyond the internal os. The edge of the spatula tip is

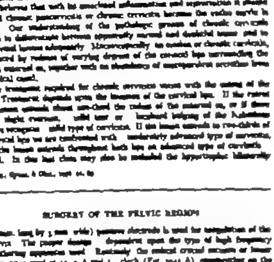


FIG. 1923. Electrosurgical treatment of infections of the cervix. Shows close proximity of the cervical artery and vein and the uterine artery and vein to the internal os, ... the cervical canal. One should keep in mind the relationship of the vascular supply to the cervical ... of the cervix ... in order to avoid severe secondary hemorrhage. Courtesy of Dr. H. O. Maryan.)

most suitable for the purpose (Fig. 1922 B). The tip is first placed firmly against the cervical tissue and then slow coagulation is begun. The amount of coagulation should be sufficient to reach beyond the gland-bearing areas and into the adjacent stroma. In this way sufficient destruction of the infected gland bearing tissue will be produced and adequate drainage provided. A conical-shaped area analogous to that which is removed by the classical Sturmdorf operation is the desired coagulation. The apparatus is operated by foot-switch control. Do not remove the electrode from the cervix unless the foot-switch is off, because undesirable fulguration will result. Should bleeding occur apply the tip of the spatula to the bleeding point; sparking will seal the bleeding vessels. The desired amount of coagulation is characterized by a grayish white color. The extent of coagulation differs with the degree of pathology encountered.

In some instances, with marked hypertrophy of the upper cervical lip, addi-

Dosage in this case as a matter of results.

tional linear striping is done at 2, 4 and ... o'clock. Further coagulation, if necessary, is done after three weeks, since the height of the tissue reaction has subsided by that time. It is then advisable to wait about 3 months before repeating treatment again. Postnasal coagulation is preferable for chronic gonorrheal infection. Short wave apparatus may be used to advantage.

Comment. Failures following coagulation or cervical plastics are usually due, as shown by Kanter and Webb, to remnants of the uppermost infected gland bearing tissue near the internal os. Patients should abstain from the use of douches during the postcoagulation period, and also from sexual relationship. Epithelialization is usually complete between 4 to 6 weeks.

Complications which may follow coagulation of the cervix are: (1) hemorrhage, (2) stenosis, and (3) pelvic infection. Bleeding during the days immediately following coagulation of the cervix is usually of no moment and is due to oozing of the sloughing surface. Very frequently severe secondary hemorrhage is encountered about the 10th or 14th day; this is the result of too extensive coagulation. In such instances, severe secondary hemorrhages may occur from sloughing of the cervical branch of the uterine artery in the region of the internal os (Fig. 1923).

Stenosis is avoided by follow-up dilatation of the cervical canal by graduated special uterine sounds (Hegar's) and topical applications of silver nitrate (about 5 per cent). Maryan stresses that with this type of prophylactic treatment of cervical disease the mortality incidence should be greatly reduced from possible malignant metamorphosis.

AMPUTATION OF THE CERVIX

This classical procedure is divided into two types: (a) Low and (b) High cervical amputation.

Low Amputation of the Cervix

In the low operation the cervix is divided laterally with sharp scissors or scalpel. A curved incision extending between the lateral incisions is made. This is followed by freeing of the vaginal mucous membrane. The anterior lip of the cervix is now amputated with the scalpel. A cervical needle (Fig. 1924) carrying chromic catgut unites the reflected portion of the vaginal mucous membrane with the raw surface of the cervix. As many interrupted sutures as are needed are introduced in such fashion as to leave no raw cervical tissue uncovered. The posterior lip of the cervix is treated in the same manner viz. incision of the lip after freeing the posterior vaginal mucous membrane from side to side and dissecting it backward, finally covering the resulting raw surface of the cervix with vaginal mucous membrane as was done with the anterior segment. Additional sutures are introduced at the angles of the wound.

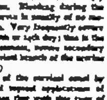


FIG. 1924. Cervix needles. (Emmet.)

Pack the vagina lightly with a strip of iodoform gauze.

The reference to time represents the relative position of the electrode to the dial on a clock.

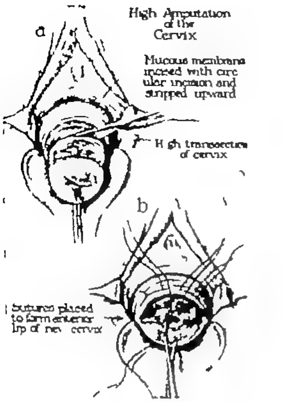


Fig. [illegible]. High amputation of the cervix. a Circumcision of vaginal mucous membrane and transection of the cervical tissue. b Placement of sutures to form new anterior lip of cervix.

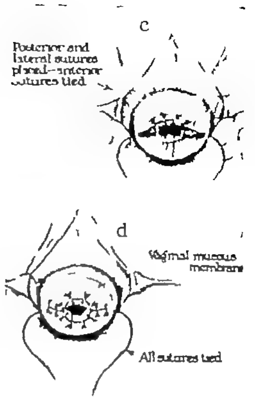


Fig. [illegible] (continued). High amputation of the cervix. c Placement of posterior and lateral sutures. d Operation completed.

High Amputation of the Cervix

Step 1. Expose the cervix by appropriate retractors. Pull it forward with vulsellum forceps.

Step 2. Circumscribe the cervix at the cervico-vaginal junction (Fig. [illegible]).

Step 3. Catch bleeding vessels and ligate them with chromic catgut.

Step 4. Expose as much of the cervix as is desired to amputate by further dissection. Amputate the cervix at the desired level.

Step 5. Cover the raw surfaces resulting from the ablation of the cervix with the detached vaginal mucous membrane (Fig. [illegible] b, c, d).

Comment. If the cervix is amputated high the uterine arteries will have to be secured and ligated. To accomplish this expose the parts thoroughly. Place an Auvard speculum in the posterior vaginal wall. The lateral walls must be thoroughly separated by retractors in the hands of assistants. Meticulous ligation of the cervical vessels is essential.

OPERATIONS ON THE NONPREGNANT UTERUS

CURETTAGE

Curetting the uterus is done for the purpose of emptying it of pathologic products and abrading its mucous membrane in part or "in toto."

Historical Notes. Curettage was introduced by Récamier in 1846. Afterward it was abandoned and later restored in the treatment of malignant tumors by Sutton in 1872, and in cases of endometritis by Hegar, Kaltenbach and Olshausen in Germany and by Doléris in France. Its restoration was followed for many years by much abuse in its use.

The dangers likely to result from curettage are: (a) perforation of the uterus, (b) hemorrhage, and (c) sepsis.

Perforation of the Uterus

This is of frequent occurrence. It happens more often during dilatation than curettage; the curet may enlarge a rent made by the dilator. Such trauma frequently occurs in the lateral cervical or uterine wall and extends into the corresponding broad ligament. If you suspect that the uterus has been perforated, STOP! Pack the vagina lightly with iodoform gauze. Get the patient back to bed, put her in the Fowler position. Apply an ice bag to the abdomen and observe vigilant expectancy. If all is well (pulse rate, respirations, abdominal signs) leave well enough alone. Do not become panicky. If the surgeon "loses his head" he often hurts his patient. If perforation results in hemorrhage into the peritoneal cavity or broad ligament, prolapse of the intestine or peritonitis, operate. In case of severe hemorrhage into the peritoneal cavity, open the abdomen and suture the rent in the uterus. If the laceration is extensive, hysterectomy may have to be resorted to. Hemorrhage into the broad ligament is usually the result of tearing the internal os. When this occurs the uterine artery is frequently injured causing severe hemorrhage. In such cases locate the laceration, expose the vessels by dividing the vaginal part of the cervix. Stop the bleeding by sutures of substantial catgut carried on curved sturdy needles. The bleeding

vessel must be secured at any cost. If unsuccessful, open the base of the broad ligament from below and suture the bleeding vessel. Should this fail, pack the vagina tightly, open the abdomen and ligate the uterine artery from above. Combat shock by appropriate measures.

Prolapse of the intestine through a laceration, while rare, does nevertheless occur. Do not try to replace the prolapsed bowel into the abdominal cavity or pack the uterus! Open the abdomen, examine the bowel for possible injuries which are repaired if found, cleanse the bowel and replace it. Close the wound in the uterus with catgut sutures.

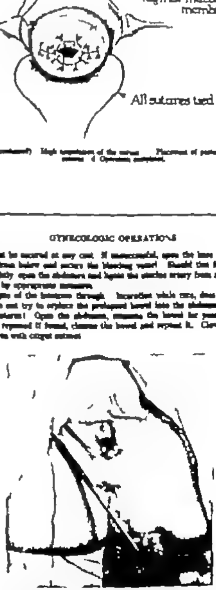


Fig. [illegible]. Labia stitched out of way for curettage or other gynecologic operation.

Peritonitis usually follows sepsis of the uterus. Local peritonitis is treated conservatively. In progressive peritonitis, drain the pouch of Douglas posteriorly through a large drainage tube.

In uterine hemorrhage, the bleeding is occasionally perpetuated by retained secundines.

In septic conditions of the uterus, curettage is usually contra-indicated. Do not empty the uterus until the temperature has been normal for some time. Sepsis caused by curettage may result in acute salpingitis, pelvic peritonitis which may become general, pelvic cellulitis, thrombophlebitis and septicemia.

Operate preferably five or six days after menstruation. Use general anesthesia.

Step 1. Place the patient in the dorsosacral position with the buttocks ex-

[illegible] over the edge of the table. Place the legs in supports. [illegible] and disinfect the [illegible]. Shave and cleanse the operative field thoroughly.

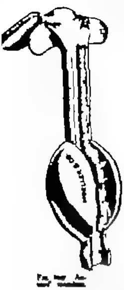


Fig. [illegible] [illegible] speculum.

Step [illegible]. Stitch the labia out of the way (Fig. [illegible]).

Step 3. Depress the posterior vaginal wall with an Auvard speculum. Locate the cervix (Fig. [illegible]). Grasp the cervix with vulsellum forceps (Fig. [illegible]) engaging its posterior lip generally about [illegible] cm from its free border in order to avoid tearing it. Draw the cervix gently and gradually down to the vulva. Introduce lateral retractors into the [illegible] (Fig. [illegible]). A second [illegible] is placed on the [illegible] lip. Drawing down the cervix has the advantage of straightening the [illegible] canal.

Fig. [illegible] [illegible] forceps. (Down.)

Step 4. Ascertain the direction and depth of the uterine cavity by means of uterine sound.

Step 5. With the aid of Hegar dilators (Figs. [illegible]) dilate the cervix sufficiently to permit the introduction of the curet (Fig. [illegible]). There are a great number of models of curets. Especially useful are those of moderately sharpened edge. It is well to have two or three different calibers. In order to reach the uterine cornua, a small ring curet is useful. Curettage should be done methodically. Project the instrument gently until it comes into contact with the fundus (Fig. [illegible]). Proceed to curet both walls of the uterine cavity from above downward. Repeat the manipulation on the same wall several times until you feel a special grating sensation described by the French under the name of "cri utérin," [illegible] which is that of touch rather than of hearing. Support the wall being curetted with the aid of the index finger of the left hand introduced into the fornix corresponding to the respective anterior or posterior wall of the uterus.

The curet should be brought out to the external os with each sweep of the curet in order to bring out of the cavity the clot and mucous membrane débris.

From time to time rinse the curet in sterilized water or an antiseptic solution in order to dislodge the scrapings clinging to the instrument.

Curettage should be more energetic at the level of the cervix because here the epithelial crypts are deeper and the lesions more pronounced than elsewhere. Be particular to carefully curet the angles of the uterine cavity.

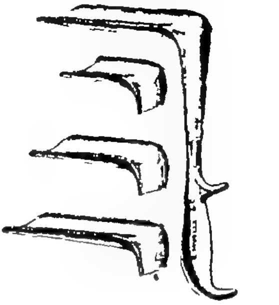


Fig. [illegible]. [illegible] retractors. (Down.)

During curettage the uterus usually contracts; on occasion its cavity increases in size and the curet enters the resistance [illegible]; instrument before and one is led to think of uterine perforation. If this be so, withdraw the curet at once and compress the uterus through the abdominal wall; rapid clots and when the organ contracts again continue the curettage. I am in the habit of giving an ampule of pituitrin subcutaneously. Immediately after the operation is concluded, resort to an intrauterine irrigation (Fig. [illegible]) or intrauterine application of an antiseptic (Fig. [illegible]).

Step 6. Tampon the vagina lightly with iodoform gauze. Remove the gauze

tampon on the second day. Confinement to bed should generally be about [illegible] week.

Hemorrhage. If [illegible] severe hemorrhage occurs during curettage, it may result from too superficial curetting and may be dealt with by completing the scraping of the diseased and bleeding mucosa. If hemorrhage persists, it may be necessary to resort to intrauterine tamponing.

Infections result from faulty technic.

Stenosis: Strictures and Obliterations of the Uterine Cavity. Stenosis has been known to result following curettage. This is often caused from atresia or partial or complete obliteration of the uterine cavity. The uterine mucous membrane rapidly regenerates after curetting, by the multiplication of the cellular

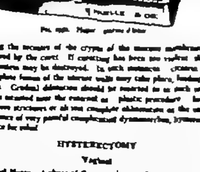


Fig. [illegible]. Hegar [illegible] [illegible].

elements lining the recesses of the crypts of the mucous membrane which are ordinarily spared by the curet. If curetting has been too violent, these cellular regenerative elements may be destroyed. In such instances, cicatricial, partial, or even [illegible] complete fusion of the uterine walls may take place, leading to stenosis or obliteration. Gradual dilatation should be resorted to in such instances. If the stricture is situated near the external os, plastic procedure [illegible] indicated. In case of extensive strictures or of the complete obliteration of the uterine cavity with the existence of very painful complicated dysmenorrhea, hysterectomy offers the only chance for relief.

HYSTERECTOMY

Vaginal

Historical Notes. Andreas of Crete is given credit for having performed the first vaginal hysterectomy in [illegible]. Marshall ([illegible]) and Langenbeck in [illegible] performed incomplete hysterectomies for uterine prolapse. Sauter in 1822, Blundell in [illegible] and Récamier in [illegible] used ligatures in the broad ligaments. Kanster in 1848, and Baumé in [illegible], removed the adnexa during the vaginal ablation of the uterus.

T. Czerny brings the credit of systematizing the procedure in [illegible]. He employed Récamier's method of applying ligatures in the broad ligaments. Czerny's successors to popularize vaginal hysterectomy were Billroth, Schroeder, Martin, Walker ([illegible]), Mikulicz, Tauffer, Kocher and Müller ([illegible]). In [illegible] Billroth reported [illegible] total vaginal hysterectomies with mortality of [illegible] per cent. Martin ([illegible]) collected from the literature [illegible] cases with mortality of [illegible] per cent. Doyen in [illegible] reported [illegible] cases with mortality of [illegible] per cent. Spencer Wells was the first to suggest the use of the forcipressure principle on the clamped broad ligament. But Jules E. Janvrin was successful with this technic in [illegible]. Doyen devised the elastic-jawed forceps in [illegible] (Figs. [illegible]).

[illegible] [illegible]. Goodell dilator.

Step [illegible]. The patient is placed in the lithotomy position with legs and hips elevated. Amputate the cervical canal by swabbing it with iodine confined to uterine application. Close the external [illegible] opening with silver silk, or silkworm gut sutures; these are tied and left long to serve as tractors. Do not fail to catheterize the bladder.

Step 2. Circumcise the vaginal mucosa at its junction with the cervix uteri. The anterior vaginal cuff is separated from the bladder by sharp and blunt (gauze) dissection. This is continued until the bladder is somewhat free on the lateral sides exposing the broad ligaments on both sides.

Step 3. Identify the vesico-uterine reflection. This is best reached by extending the gauze dissection upward and retracting the bladder (upward) out of the way. Its smooth color will aid in recognizing the peritoneal fold. Its identification is enhanced by having the index finger glide over its surface thus gaining the digital impression of the two peritoneal surfaces gliding over one another. Open the peritoneal fold. Introduce both indices and spread them laterally as if dilating a rectal sphincter. Through this opening introduce a warm lap sponge, of appropriate size, into the pelvis to keep the bowels out of the way. It is important to separate the bladder sufficiently laterally

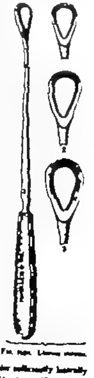


Fig. [illegible]. Uterine curets.

[illegible] Fig. [illegible] in conjunction with the text as well as that describing the next (Doyen's) type of vaginal hysterectomy.

... each broad ligament in order to displace the uterus upward and out of harm's reach.

4. Separation of the rectum from the uterus. Forcibly pull the cervix upward. Before doing so place an artery forceps on the tape of the lip

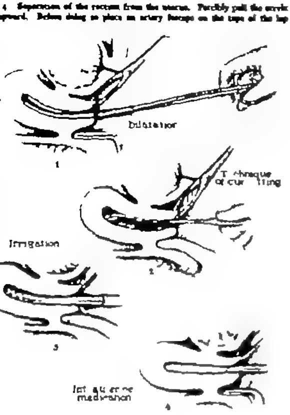


Fig. 1992. Technic of curettage

pack introduced between the bladder and uterus. Treat, in principle, the posterior vaginal cuff similarly to the anterior one, viz., dissect it away from the uterus up to the posterior peritoneal pouch. Open the culdesac of Douglas. Isolate the broad ligaments. The uterus is now held suspended

in the pelvis by the broad, uterosacral, infundibulopelvic and round ligaments.

Step 5. Ligation and division of the broad ligaments. A curved Mayo needle carrying No. [illegible] or [illegible] chromic catgut suture engages the lower edge of the broad ligament, which is ligated, tied and left long, to be used temporarily as a traction-suture. Divide this portion of the broad ligament close to the uterus. Treat another segment of tissue above the first ligature similarly. Introduce the needle under the guidance of the finger and suture as large a segment of broad ligament as is consistent with safety. The higher the separation of broad ligament from the uterus proceeds, the greater the mobility of the uterus becomes. Treat the broad ligament on the other side

Fig. 1993 Fig. 1994

Fig. 1993. Prolapse of the uterus (second degree).
Fig. 1994. Complete prolapse of the uterus.

similarly. Hook a finger over the top of the broad ligament on one side. Place safety ligatures and sever the ligament from the uterus. If a salpingectomy or salpingo-oophorectomy is to be done simultaneously, the ligatures are placed where indicated (infundibulopelvic ligament). Repeat the procedure on the opposite side. Keep in mind at all times the importance of thorough hemostasis and the avoidance of injury to the ureter and the adjacent viscera (rectum, prolapsed small bowel, bladder). Inspect the pedicles of the ligamentous structures held by the traction sutures. Put in additional sutures where hemostasis seems incomplete.

Step 6. Remove the gauze-pack from the anterior culdesac. Isolate the divided edge of the bladder peritoneum. Unite the broad ligaments by bringing the sutures which were left long into apposition. Additional sutures are used to unite the divided ligaments. The order of uniting the severed ligaments is as follows: bladder peritoneum and round ligaments; broad ligaments and finally the vaginal vault. Provide for drainage (tube or cigarette drain) in the posterior opening leading into the pelvis.

Step 7. Close the vaginal vault. If cystocele and rectocele are present, repair them. Pack the vagina lightly.

Doyen's Vaginal Hysterectomy

This is undoubtedly the most rapid method of performing vaginal hysterectomy.

Step 1. Opening and exploring of the culdesac of Douglas. Retract the posterior vaginal wall (weighted speculum). Engage the posterior lip of the cervix in a vulsellum forceps; displace it upward. Do a posterior vaginal colpotomy. Enter Douglas' pouch. Introduce both index fingers, develop the opening thus created, transversely. Explore the posterior surface of the uterus and adnexa through the opening thus made.

Step 2. Opening of the anterior vaginal culdesac and detachment of the bladder. Introduce a flat vaginal retractor and exert traction toward the pubes. Grasp the anterior lip of the cervix with a vulsellum forceps and pull it downward. Enter the anterior vaginal culdesac. The circular incision of the vaginal attachments of the cervix is thus completed. To avoid injury to the bladder, direct the point of the scissors toward the cervix. A gauze covered finger aids in separating the bladder from the supravaginal portion of the cervix. This must be done thoroughly and the bladder cleared high up lest injury to it and the ureters results.

Step 3. Median anterior hemisection of the cervix. Entering the anterior peritoneal space. Median anterior hemisection of the body of the uterus and its delivery. Retract the bladder anteriorly. Grasp the cervix with two strong toothed vulsella forceps. Divide the anterior cervical lip between the two vulsella with a pair of straight scissors (Fig. 1995 a, b). If not already opened, the vesico-uterine peritoneal culdesac is now entered. Apply another pair of vulsella above those already placed and extend the incision into the anterior uterine wall higher up (Fig. 1995 c). In large uteri the anterior retractor is removed, the index finger of the right hand is introduced between the bladder and uterus and the vulsella are placed above the second pair and the incision extended further up. Traction on the highest vulsellum forceps will now bring the fundus of the uterus into view. If difficulty is encountered at this stage of the operation by reason of narrowing of the vagino-peritoneal aperture in nulliparous women, two fingers in the anterior culdesac deliver the fundus, or [illegible] obtained by grasping the top of the fundus uteri with a strong pair of vulsellum forceps and dragging it into the field of operation (Fig. 1995 d). The adnexa may also be brought down in this manner. The ligamentous structures are taken care of by ligation as described above, or by crushing forceps. The uterus is cut away between the ligated ligamentous structures and the forceps which have been placed proximal to the uterus (Fig. 1995 e, f, g).

If pressure forceps are used instead of ligatures, the surgeon may elect (in various combinations) to apply the forceps from above downward. The treatment of the stumps proceeds as outlined above (Steps 5-7 p. 1803).

In adenomyoma and denervate cases excision of the broad ligament is very efficacious. G. L. Hunner advises passing a chromic catgut suture just beneath the urethral sphincter then through the stumps of the upper third of

Fixed Steps 5 and [illegible] on page 1793.

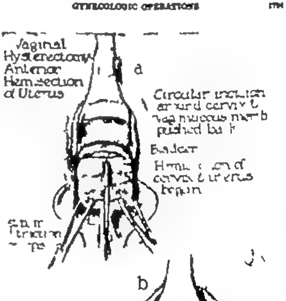
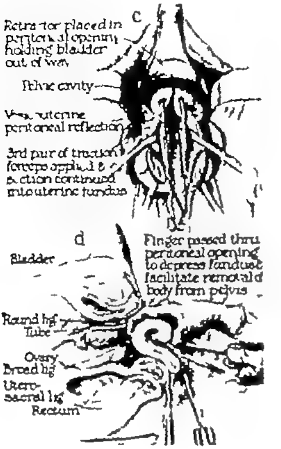


Fig. 1995. Doyen vaginal hysterectomy. ... Posterior vaginal colpotomy. Douglas pouch entered. Anterior culdesac opened, bladder detached. Median anterior hemisection of the uterus with straight scissors. ... Hemisection of uterus continued between vulsella placed higher up.



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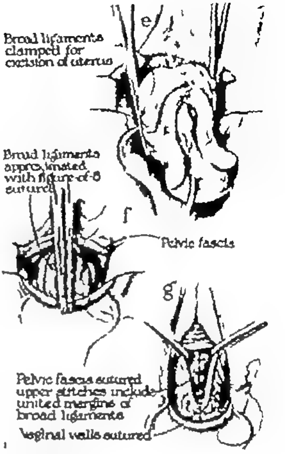


[illegible]

[illegible]

ABDOMINAL HYSTERECTOMY

[illegible]

Abdominal, Supravaginal (Supracervical) Hysterectomy

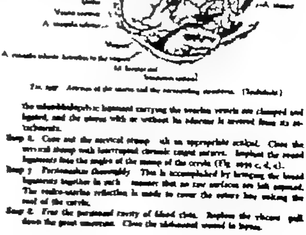
[illegible]

Step 1. [illegible]

Step 2. [illegible]

Step 3. [illegible]

[illegible]



[illegible]

Kelly's Sagittal Bisection of the Uterus

This operation offers many advantages, viz.:
(a) Preliminary control of the uterine vessels.
(b) Additional room for thorough work.
( ) Better access of approach in difficult cases.

Fig. 1698. Trendelenburg position.

(d) In instances where the lateral masses are adherent, they may be enucleated with safety with scalpel or scissors, or they may be enucleated with forceps, et cetera.

(e) Injury to contiguous organs (rectum, ureters, great vessels) may be avoided.

Step 1. Grasp the fundus and pull it upward with Museux vulsellum forceps. Divide the body of the uterus in the median line with strong scissors, to a point below its peritoneal reflection (Fig. 1960).

Step 2. As the operation progresses the Museux vulsellum forceps are relaxed and reapplied on the cut surface, not unlike the procedure in Doyen's vaginal hysterectomy (p. 1704).

Step 3. One-half of the bisected cervical part of the uterus is next cut laterally toward the broad ligament. While this is being done the Museux vulsellum forceps grasp the horizontal surface of the divided uterus pulling it upward thus exposing the uterine vessels.

Step 4. Ligation of the uterine vessels is next done (Fig. 1960 b). Repeat the procedure on the opposite side. The further steps of the operation are essentially those of the classical supravaginal hysterectomy. After the removal of the uterus the adherent adnexa may be dealt with by dissection proceeding from within outward (Fig. 1960 c, d).

The operation may be extended and the cervix also removed (panhysterectomy). In those cases where the adnexa on both sides are much involved, and the uterus is so plastered down with adhesions that it cannot be bisected as described, Kelly advises horizontal bisection which consists of dividing the bladder peritoneum from side to side, pushing the bladder toward the cervix and bisecting the exposed cervix horizontally.

Total Hysterectomy (Panhysterectomy)

In this operation the cervix is also removed.

The same steps are carried out as in the supravaginal operation with the following steps added:

(a) The bladder is pushed down in front of the cervix.
(b) Be oriented on the relative lateral positions of the ureters.
(c) Clamping, dividing and ligature of the lateral cervical tissues (parametrial).
(d) Opening the vagina.
(e) Removal of the cervix.
(f) Closure of the vaginal vault with or without drainage.

Comment. Separate the bladder first in the median line and then laterally. Without identifying the ureter on either side of the cervix, the surgeon can never be sure that it is out of harm's way. The vagina is incised longitudinally. Immediately after it has been opened it is grasped with Ochsner forceps and a strip of iodoform gauze is pushed into it, to be removed later. In cases where, during the preparation of the vagina, a strip of iodoform gauze has been placed there, as is often done, it is pulled up through the open vaginal vault to be used as a drain after the operation. In excising the cervix, shortening of the vagina should be avoided by cutting the vaginal tissues quite close to its cervical attachments. The vagina is closed about a cigarette or rubber tube drain.

DOYEN'S PANHYSTERECTOMY

Step 1. Introduce a long sturdy curved forceps into the vagina; it is pushed up forcibly behind the cervix by an assistant, causing the posterior vaginal cul-de-sac to bulge as high as possible.

Step . Incise the tensed tissues longitudinally with a sharp scalpel, permitting the vaginal forceps to enter the abdomen through the opening thus made (Fig. 1961).

Step 3. Enlarge the opening in the vault of the vagina by dividing

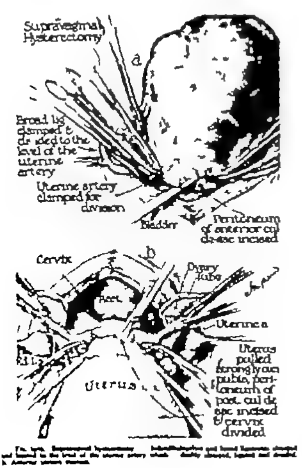


Fig. 1960. Supravaginal hysterectomy. a, Infundibulopelvic and broad ligaments clamped and ligated to the level of the uterine artery which is doubly clamped, ligated and divided. b, Anterior uterine incision.

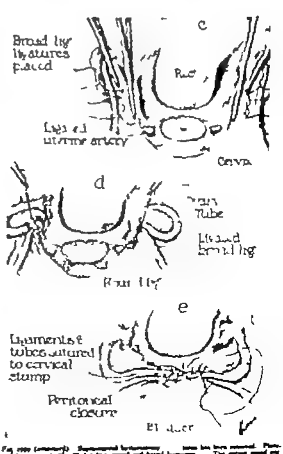
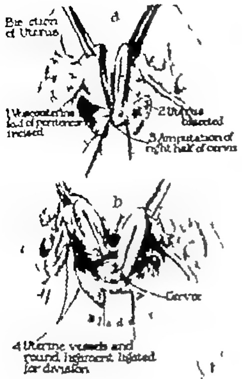
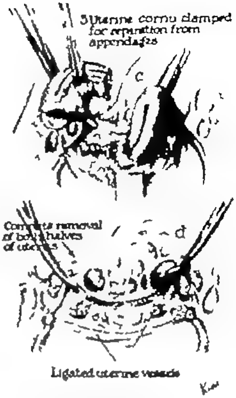
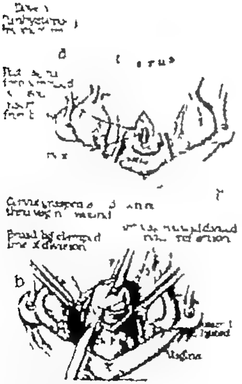
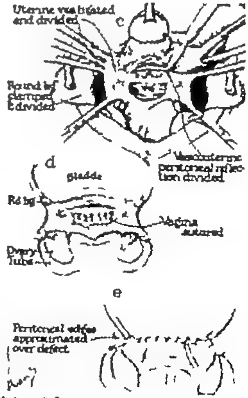


Fig. 1960 (continued). Supravaginal hysterectomy. Uterus has been removed. Placement of ligatures on infundibulopelvic, round and broad ligaments. The cervical stump is covered over. Round ligaments sutured to cervical stump. Peritoneal closure.


a
1 Vesicouterine fold of peritoneum incised
2 Uterus bisected
3 Amputation of right half of cervix
b
Cervix
4 Uterine vessels and round ligament ligated for division


5 Uterine cornu clamped for separation from appendages
c
d
Ligated uterine vessels


a
b
Vagina


Uterine vessels ligated and divided
c
Round lig. clamped & divided
Vesicouterine peritoneal reflection divided
d
Bladder
Rd lig.
Vagina sutured
Ovary
Tube
e
Peritoneal edges approximated over defect

Step 4. Introduce the index finger into the vagina, locate the cervix, grasp it with a Museux forceps and deliver it into the abdominal wound (Fig. 1961 b).

Step 5. While traction is applied to the fundus of the uterus, the vaginal attachments are severed with curved scissors from the cervix and the anterior culdesac is entered.

Step 6. Free the anterior portion of the cervix from its attachments. The operative steps are now continued as described above (Fig. 1961 c, d,).

Comment. Genital Prolapse following Total Hysterectomy. R. L. Payne[1] discussing the subject of genital prolapse following removal of the uterus points out that:

After any type of vaginal hysterectomy a marked genital prolapse often happens in which the vagina becomes completely everted and the bladder partially or completely protrudes. With the cervix and its attached supports entirely wanting in these cases, the problem of returning the bladder to the abdomen and fixing it there through any type of vaginal operation, is, practically speaking, impossible.

In all the literature and textbooks on this question of genital prolapse after total removal of the uterus, the only procedure offered to relieve this trouble is colpocleisis. Simon, in 1867, originally recommended and described colpocleisis for the cure of intractable vesicovaginal fistula, but for the past twenty-five years or more, colpocleisis has been undertaken repeatedly for the cure of genital prolapse after total removal of the uterus. Needless to say, not only is this operation a poor surgical procedure, which is rather difficult to accomplish properly and gives a poor result in many instances, but it is definitely disfiguring.

Payne devised the technic depicted in the accompanying illustrations and legends (Fig. 1962). He has done this operation only four times, the last one two years ago and the first one more than ten years ago. In these four cases, the result has been entirely satisfactory.

Payne does not claim this to be a new operation; all the steps or principles have been utilized for years in other gynecologic problems. The technic merely covers the application of well-known principles which, so far as he can discover, have not been described in the literature or applied to the handling of this particular problem of prolapse after total hysterectomy.

Hysterectomy for Carcinoma of the Uterus
(Ries-Wertheim Operation)

In this country Emil Ries, Werder, Sampson and Clark, and in other countries Wertheim, Freund and others contributed much to the development of the extended operation for uterine carcinoma. Its performance requires one to be a good anatomist, with an ample knowledge of pathology and to command a good technic; coupled with these a careful selection of cases will tend much to lower the operative mortality in this class of cases.

[1] Annals of Surgery, Vol. XX, 1930.

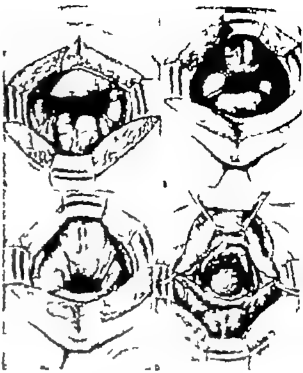
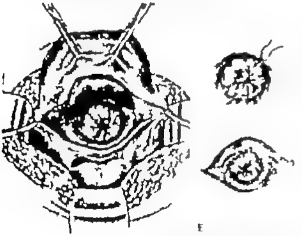


Fig. 1962. Payne's operation for genital prolapse following total hysterectomy. A. The [illegible]

Step 1. This consists of disinfection of the vagina, preceded by a thorough electrocoagulation of the accessible carcinomatous tissue and thorough packing of the vagina with iodoform gauze. It is good insurance to catheterize the ureters to avoid injuries during the operative manipulations.

Step 2. High Trendelenburg position. Ample subumbilico-parumbilical incision. Thorough protection of the bowels away from the field of operation. The pelvis must be free to afford facility of operative manipulations.

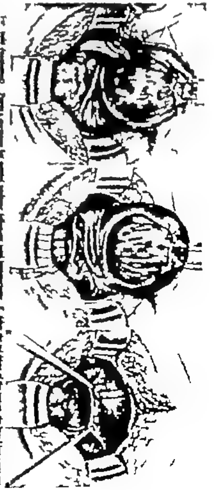


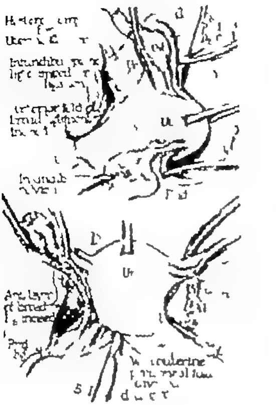
E

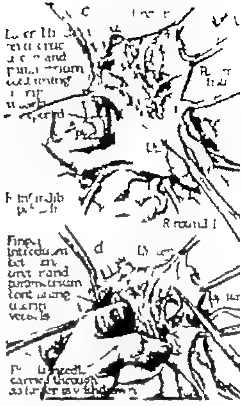
[illegible] (continued). Payne's operation for genital prolapse following total hysterectomy. E. [illegible]

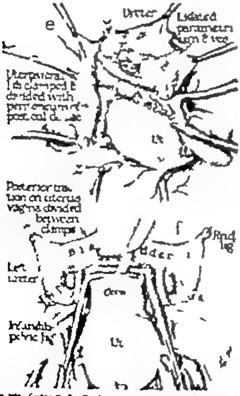
Step 3. Engage the fundus of the uterus in a strong vulsellum forceps, draw strongly upward and forward. Divide the infundibulopelvic ligament (Fig. 1963) on the side the operation is begun. Incise the peritoneum toward the round ligament. Doubly ligate the round ligament and divide it. Repeat the same procedure on the other side. The body of the uterus is now practically free on both sides.

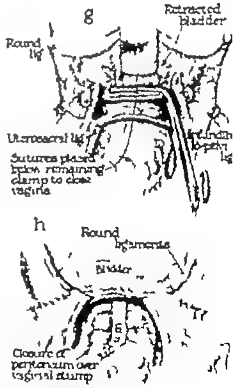
Step 4. Incise the peritoneum. Free the urinary bladder by blunt gauze dissection aided, by scissors dissection where deemed advisable, from the whole anterior surface of the uterus to a little below the vault of the vagina (Fig. 1963 b). Place a retractor in front, to hold the separated bladder out of the way. Ligate and divide the uterosacral ligament posteriorly, joining the






c
d


e
Ureter
Ligated parametrium
Posterior traction on uterus vagina divided between clamps
f
Rnd lig
Left ureter
Infundib-pelvic lig
Ut


g
Retracted bladder
Round lig
Uterosacral lig
Sutures placed below remaining clamp to close vagina
h
Round ligaments
Bladder
Closure of peritoneum over vaginal stump

posterior with the anterior incision. Separate the rectum from the upper part of the vagina.

Step 5. Locate the ureter (Fig. 796). This is one of the very important steps of the operation. Draw the uterus to one side, locate the uterine artery close to the uterus, ligate it doubly and divide it. The ureter lies in the parametrium immediately below the uterine vessels. It may be picked up between the fingers at the base of the broad ligament on the pelvic floor and identified by the characteristic firm sensation it imparts to the palpating fingers. If not recognized by this maneuver, it should be located at the pelvic brim, tracing it down to the aperture in the lower part of the broad ligament through which it passes beneath the uterine artery. A boring movement of the index finger from beneath forward enlarges the tunnel through which the finger passes, having above it the parametrium and vessels (Fig. 796, d) and below the ureter. The illustration shows the method of securing the uterine artery and safeguarding the ureter. Do not denude the ureter from its surrounding structures; rather displace it by pushing it off the tissues. In many cases the freeing of the ureter may prove extremely difficult (Fig. 796). Cancer tissue seldom, if ever, invades the ureteral structures; if this should happen a resection of the involved portion may become imperative (which see) followed by uretero-ureteral or ureterovesical anastomosis. When both ureters have been liberated the cervix remains attached only by the upper part of the vagina.

Step 6. Complete the separation of the base of the bladder in front of the cervix and vagina as far down as is deemed necessary for thorough work, as well as from its lateral attachments to the parametrial and paravaginal tissues. The parametria should be thoroughly dissected out with the lymph nodes contained in them. In some instances this is accomplished with facility while in others, marked infiltration will render this step extremely difficult. Wertheim's parametrial clamps act admirably to grasp the paravaginal tissues preliminary to ligation and division.

Step 7. An assistant removes the vaginal pack. Readjust the lap packs and retractors.

(a) Open the vaginal vault in front by continuing the incision around the vagina which is held by artery forceps as the incision continues, or

(b) The vagina is freed all around and palpated in order to make sure that it is freed beyond the infiltrated area. Two vaginal clamps (Fig. 796, f, g) are made to grasp the vagina which is severed between the clamps. Immediately after the removal of the cancerous uterus, disinfect the stump of vaginal cuff with tincture of iodine. The vagina may now be closed completely in cases reasonably free from contamination. As a rule, I prefer providing drainage [illegible] by suturing the vagina around one or two [illegible] ligaments [illegible] and covering the vault with peritoneum. Or the vaginal vault may be closed by first suturing its margins to their respective peritoneal folds (Fig. 796, h) after which the vesicouterine peritoneum is joined to the rectal peritoneum.

Step 8. A thorough survey of the operative field is now made. Peritonization

must be meticulous by careful covering of raw surfaces and the exposed ureters.

Step 9. Change gloves and substitute fresh instruments for those used. Close the abdomen in layers.

Comment. Every precaution should be taken to avoid contamination. The ureters should be handled with utmost care. Postoperative cystitis is not unusual. If present, treat it symptomatically. Avoid urinary retention. Occasionally ligation of both internal iliac vessels is practiced.

Since the advent of radium and deep x-ray therapy the extensive Rees-Wertheim procedure has yielded much ground to hysterectomy with removal of only moderate amounts of the parametrial tissues followed by x-ray and radium therapy.

ARTERIAL LIGATION AND LYMPHATIC BLOCK FOR IRREMOVABLE CARCINOMA OF PELVIC ORGANS

Historical Notes. The application of ligatures to blood vessels is said to have been practiced at least eighteen hundred years before the vascular system itself was understood. It is not known who first employed the method, but ligation of bleeding vessels for the control of hemorrhage is mentioned in the writings of Celsus (30 B.C. to 50 A.D.) and of Galen (131– A.D.), Aetius (502–575 A.D.), Antyllus (560–627 A.D.), and others of the early authorities on surgery. The ligature was used for the control of hemorrhage and in the treatment of aneurysm.

When Ambroise Paré, the great French surgeon, revived interest in the ligature in [illegible], he improved the method of its application, and extended its field of usefulness. Paré brought the surgeons of his day to abandon the "old and too too cruel way of healing" by the use of the "red hot iron," and to embrace the new method of controlling hemorrhage by binding the vessels "toward their roots."

The beginning of the eighteenth century found the surgeons of the world still using the actual cautery for the control of hemorrhage.

Thus, it will be seen that while the ligature of arteries was practiced for centuries before Harvey discovered the circulation of the blood (1616–1628), its use was limited to the control of hemorrhage and the treatment of aneurysm.

With Harvey's discovery of the circulation of the blood and the development of the knowledge of the part played by the blood in the nourishment of tissue, [illegible] as well as normal, the method of ligating arteries increased in scope. It is now applied for the purpose of causing atrophy of organs and other parts of the body and of lessening the nutrition of inoperable and nonoperable new growths, thus retarding their further development.

The particular use of the ligature has given rise to the term "starvation ligature," and the procedure has been applied to the uterus, ovaries, testes, spleen, thyroid, tongue, brain (epilepsy) and other parts of the body.

The discovery of the circulation of the blood is logically credited with originating the newer application of the ligature in surgery and for a long time the method was known as "Harvey's method." In 1651 he is said to have successfully treated [illegible] of [illegible] of the scrotum and testicle by ligating the spermatic artery. So far as is known no further application was made by Harvey of this procedure.

The next recorded application of the starvation ligature is that of Lamp, who, in 1707, employed the method in the treatment of goiter.

So far as Bainbridge has been able to ascertain from the literature, hundred years elapsed before the method was revived with any definiteness.

Trevan, in 1809, tied the superior carotid artery in the treatment of [illegible] of the orbit, said by some writers to be a fungous growth and by others to be an aneurysm.

From this time on the method was employed in a more or less desultory manner for various purposes, particularly in the cranial region. In 1898 the history of this special application of the ligature was traced by John A. Wyeth, and his own original work described.

Interest in the procedure was again aroused, in 1903, when Dunham reviewed the history of the subject briefly, and explained his own modifications of the method, viz., the resection of the external carotid arteries, possible ligation of the lingual branches, injection of an outer location with liquid paraffin, after the suggestion of Wyeth.

Starvation Ligature in the Treatment of Malignant Pelvic Tumors

Historical Notes. The application of the starvation ligature to the pelvic organs was first recorded by French, who, in 1889, advised and practiced ligation of the uterine arteries in cases of fibroma of the uterus. He was followed by a number of surgeons.

To Baumgartner seems to belong the credit for having first tied internal blood vessels in the treatment of nonoperable cancer of the uterus, the report of which was published in 1888. The uterine arteries were ligated by way of the vagina, when this was possible, or if not, the ligature was applied to the anterior trunk of the internal iliac, at the origin of the uterine artery. Unfortunately no details are given concerning the technic which he employed.

Kelly in 1893, ligated the internal iliac arteries in the treatment of a case of cancer of the uterus, the procedure in this instance being one of emergency rather than of election, for the purpose of checking unexpected and otherwise uncontrollable hemorrhage. In the course of abdominal hysterectomy for squamous-cell carcinoma of the cervix with extension to both broad ligaments, the ligaments cut through and free hemorrhage ensued. Both internal iliac arteries were ligated, the hemorrhage was controlled and the operation was completed. The patient's condition was such, however, that it was impossible to remove all the diseased tissue. When, six months later, the patient was readmitted to the hospital to be treated for [illegible] symptoms, careful examination failed to reveal the slightest evidence of the carcinoma. The patient died two months after the operation, presumably from the result of the extension of the growth.

In 1896 Dr. W. R. Pryor of New York ligated the internal iliac arteries with the avowed purpose not only of controlling hemorrhage but for the "starvation of tissues which cannot safely be removed." "In all cases," he said, "of cervical cancer where the infection has extended to the pelvic glands, in all cases of recurrence after hysterectomy and in so-called inoperable cases I advocate the ligation of both internal iliac arteries as a step preliminary to any other. My object," he further stated, "is to remove all the tissue I can, and what I cannot remove I want to starve. I do not expect radical cure in every possible where even the glands are affected but I believe that at least palliation is possible."

Pryor ligated, through a median abdominal incision, the ovarian, the internal iliac and the obturator arteries. He simultaneously ligated both internal iliacs for malignant disease of the uterus in thirty-four cases, with one fatality. In his experience, life was much prolonged and suffering diminished.

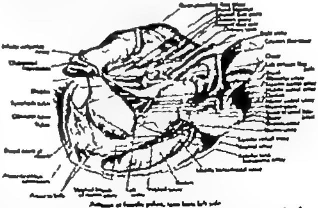
Polk, in 1896, Hausmann and Tuttle, Bruce (1897) in 1902, de Rouville, in 1902, Cumston, in 1903 and a number of others have added to the literature of arterial ligation in the treatment of neoplasms of the pelvic organs.

Anatomical Considerations (Fig. 796a). Ligation of the uterine arteries alone is not always sufficient to control hemorrhage, nor is it so effective in the starvation of the malignant growth, as ligation of the anterior trunk or of the internal iliac itself. Now ligation of the utero-ovarian arteries collateral in all cases, the blood supply to the parts being maintained through the anastomoses of other branches of the internal iliac, or possibly through the establishment of collateral circulation. In Bainbridge's early experience the ovarian and uterine arteries were ligated, etc. If the uterine could not be reached, its anterior branches were tied off, as the anterior

division of the internal iliac was ligated on the side of the most extensive involvement, the ovarian and uterine of the opposite side being ligated at the same time.

Ligation of the internal iliac artery of each side close to the bifurcation of the common iliac, thus shutting off all the branches of the posterior and anterior trunks of the internal iliac arteries, diminishes the chief blood supply of the uterus, vagina and pelvic floor. If these are accessible without cutting into cancerous tissue, and if deemed necessary or advisable, the obturator, pudendal vessel, or other branches of the internal iliac may be ligated individually as practiced by a number of surgeons, in addition to the usual ligation of the internal iliac.

If, in addition to the internal iliacs, the ovarians and the sacra media (if developed large enough to warrant it) are ligated, the blood supply is sufficiently lessened to



Arteries of female pelvis, seen from left side.

[illegible]

control hemorrhage and, usually, all subsequent hemorrhage of any severity and to offer a reasonable hope of checking the growth of the neoplasm.

From the above it may be fairly asserted that in many instances failure may be attributable to the fact that the ligation was not sufficiently extensive to control the blood supply to the pelvic organs, thus proving ineffectual in either of the purposes for which it is usually applied, namely, the control of hemorrhage and the retardation of the growth. Bainbridge found this to be the case, and gradually extended the method accordingly.

BAINBRIDGE'S OPERATION

Bainbridge's amplified method, which has proved efficacious in a number of cases, extending over a period of twenty-five years, is that of arterial ligation, with the additional safeguard of lymphatic block to prevent, as far as possible, the extension of the disease through the lymphatics. It is definitely a procedure for advanced cancer of the pelvic organs where complete removal seems im-

OPERATIONS FOR THE REPAIR OF INJURIES TO THE URETERS DURING HYSTERECTOMY

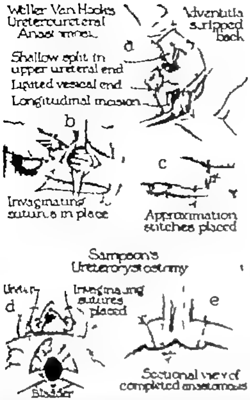


Fig. [illegible]. The Weller Van Hook ureteroureteral anastomosis. [illegible]

surface of the bladder; both needles are directed in the same course. The loop of both sutures when gently dragged upon bring the ureter into the bladder when the sutures are tied.

Step 4. Anchor the bladder wall about the ureter as described above.

KRÖNIG MODIFICATION OF SAMPSON OPERATION

This consists of omitting one U-suture.

Comment. When the Sampson or Sampson-Krönig operation has been done, leave an indwelling catheter in the bladder for a few days.

End-to-Side Uretero-ureteral Anastomosis

WELLER VAN HOOK'S OPERATION

Step 1. Ligate the distal end of the ureter. About 5 mm. below the ligated point make a longitudinal incision approximately twice the diameter of the ureter.

Step 2. Split the proximal end of the ureter for about 4 mm. On the wall opposite this, introduce a U-chromic catgut suture as shown in the illustration (Fig. 965 a, b, c) bringing the proximal ureteral end into the split distal segment and there secure it.

Step 3. Secure the slit to the invaginated ureteral part by interrupted fine linen or silk sutures. Catgut sutures may be used.

End-to-End Uretero-ureteral Anastomosis

When the ureter has been divided too high for the junction of the proximal end with the bladder, it may be implanted in the distal portion of the ureter beyond the area of ligation. The difficulties here are

(a) the difficulties presented in joining the ends of the divided ureter and

(b) postoperative blocking of the outflow of urine by reason of operative edema. The best way to overcome this difficulty is by

1. End-to-end union over a ureteral catheter;
2. Introduction of a second catheter into the proximal portion of the ureter to drain off the urine (Bump and Crowe).

(See also chapter on Surgery of the Genito-Urinary Organs, p. [illegible])

Step 1. Make a longitudinal slit in the proximal portion of the ureter. Insert a No. 4 or 6 ureteral catheter distally toward the bladder, bridging the gap between the divided ureteral ends.

Step 2. Unite the severed ends with fine chromic catgut. The sutures pass through all the layers of the ureteral wall except the mucous membrane which should be avoided.

Step 3. Pass now a No. 6 ureteral catheter through the longitudinal slit made in the upper segment of the ureter; pass it upward toward the pelvis of the kidney. This catheter diverts the urine, thus avoiding leakage at the site of anastomosis.

Step 4. The ends of both ureteral catheters are brought out through a stab wound in the lumbar region.

Comment. The catheters are removed in about a fortnight. The urinary fistula usually closes within a few days.

Treatment of Ureteral Injuries Discovered After Operation

According to Cosh and Fuchs, about 5 per cent of unilateral ligation of the ureter show no symptoms. A ureter ligated with catgut will open sufficiently to allow sufficient drainage in six to eight weeks. They urge that as soon as ligation of a ureter is discovered nephrectomy should be performed. These authors have the following to say on the question at issue:

"Consider the difficulties of deligating a ureter such as re-opening an abdominal wound and searching for a small bit in a pelvis imbedded with exudate, and the ureter incorporated in the ligature with the uterine vessels, with consequent danger of hemorrhage and the possibility of cutting the ureter with resulting fistula. This is certainly a more serious operation than a nephrectomy. The same may be said concerning uretero-ureteral anastomosis with the exception of the hemorrhage. We are of the firm belief that the safest method of protecting the individual when a ligated ureter has been discovered is immediate nephrectomy.

"We are impressed that dealing with a single ligation such as we propose may not have as large a field as it seems. In the first place, the diagnosis of single ligation may prove difficult, as the symptoms may be slight. However, if a woman who has undergone a pelvic operation complains of pain in the kidney area about the third day and this is found to be large and palpable, not having been so beforehand, such symptoms are highly suggestive of ureteral ligation. If the patient's condition should warrant it, ureteral catheterization would clinch the diagnosis. It is then up to the surgeon to decide whether it is better for the patient to let the kidney die or to try to protect it. It seems certain that no reputable surgeon would hesitate to make this situation known and provide the good chance of saving the kidney. The danger of a unilateral nephrectomy should be extremely slight, as it can be done under local anesthesia or quickly under gas.

"With such a fair chance of the ureter opening and the kidney healing in good condition, we believe that this should be the procedure. Granting that it may not be successful, even then the patient's ultimate condition is as good as it would have been had the attempt not been made, and we would have filled our chief urological duty, namely, to attempt to conserve the renal parenchyma."

When both ureters have been ligated, the sooner the diagnosis is made the better. Institute under such conditions the following:

1. Bilateral nephrostomy.
2. Deligation.
3. Ureterovesical, uretero-ureteral anastomosis or
4. Transplantation of the ureters into the bowel.

The first is the method of choice (Cosh).

Nephrostomy

(See under Operations on the Kidney, p. [illegible])

DISPLACEMENT OF THE UTERUS

Historical Notes. Alquié of Montpellier announced the first definite plan for the surgical correction of retro-displacement of the uterus (experimental studies of shortening of the round ligaments through the inguinal canals on cadavers and cadav-

ers). Alquié's report was referred to a committee composed of Bouillaud, [illegible] and Villeneuve, [illegible] Alexander of Liverpool. [illegible] James A. Adams of Glasgow performed the same operation [illegible] Howard A. Kelly of Baltimore and Olshausen of Berlin. [illegible] Mackenrodt [illegible] Dührssen described [illegible] Wertheim. In [illegible] Goldspohn of Chicago modified the Alexander operation [illegible] J. Clarence Webster [illegible] Baldy [illegible] A. D. Dudley [illegible] and numerous others described modifications of greater or lesser importance which appeared in the literature from time to time.

Extraperitoneal Shortening of the Round Ligaments

ALEXANDER-ADAMS OPERATION

Step 1. Make an incision two or three inches in length as for an operation for inguinal hernia. Expose the external inguinal ring. Identify it by the

external and internal pillars and arcuate fibers. Open the inguinal canal on a grooved (Kocher) director by dividing the external abdominal oblique fascia to about the level of the internal inguinal ring.

Step [illegible] Isolate and deliver the round ligament by hooking it up as soon as

Fig. [illegible] Alexander-Adams operation. [illegible]

the left index finger. The ligament appears as a round cord of reddish hue in the vicinity of the internal inguinal ring, which becomes thicker in diameter as it is pulled outward. Do not attempt to isolate the ligament at the external inguinal ring, but [illegible] result, because in this locality the ligament consists of attenuated fibrous strands of greater or lesser density

sheet. Careful upward dissection will usually lead to its isolation. The ligament is then pulled out by means of forceps as far as desired to bring the uterus in proper position.

Step 3. Fold the ligament on itself or suture the excessive portion; suture it in place to the fascia of the external abdominal oblique muscle with interrupted (chromic) catgut sutures. Repeat the same procedure on the opposite side.

Step 4. Restore the inguinal canal to avoid the occurrence of hernia. Close the skin; dress the wound.

[illegible] MODIFICATION (FIG. [illegible])

Open the peritoneal cavity by opening the peritoneal cuff. Introduce the index fingers and explore for existing complications of the uterus or adnexa. Bring the uterus into the proper position.

Comment. The Alexander-Adams operation should be performed only when the uterus is freely movable and other pelvic pathology can be excluded with reasonable certainty.

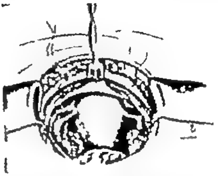


Fig. [illegible] Olshausen's operation of ventrofixation of the uterus. [illegible]

VENTROSUSPENSION AND VENTROFIXATION

It is deplorable that some surgeons even today use these terms interchangeably. Ventrosuspension aims to suspend the uterus (ligaments or uterine surface to peritoneum only), while ventrofixation aims at fixing (firm union of the uterus to the abdominal wall with sutures [illegible] are made more or less to embrace the entire thickness of the abdominal wall). [illegible] are reserved to [illegible] the child bearing period [illegible] must needs be confined to individuals in whom conception is out of the question. In ventrosuspension (Kelly operation) the posterior surface of the fundus of the uterus [illegible] sutured to the parietal peri-

toneum by two or three sutures of silk. It is not much used nowadays having given way to other procedures to be described later.

Ventrofixation of the Uterus

OLSHAUSEN'S OPERATION

Step 1. Open the abdomen with the patient in the Trendelenburg position. Engage the edges of the peritoneum and fascia in artery forceps.

Step [illegible] Pick up each round ligament near its uterine attachment with a pair of curved artery forceps. Pass [illegible] chromic catgut suture on a curved round needle through the fascia, muscle and parietal peritoneum; pass the needle now through the round ligament and return the suture to the surface in reverse order. Tie the suture. Repeat the procedure on the opposite side (Fig. [illegible]).

Step 3. Close the abdomen in layers.

Comment. This operation fixes the fundus of the uterus securely to the anterior abdominal wall about two inches above the pubes. Kelly's modification consists of using the utero-ovarian instead of the round ligament. Leopold's modification consists of having the sutures pass directly through the uterine tissue. Vineberg's method makes use of a combination of Olshausen's and Leopold's technics.

Transperitoneal Transplantation of the Round Ligaments

GILLIAM OPERATION

Step [illegible] Place a temporary ligature on the round ligament about [illegible] inches from the uterus. Catch the ends of that ligature with a pair of curved long artery forceps. Repeat the procedure on the opposite side.

Step [illegible] Retract the structures overlying the aponeurosis of the external abdominal oblique muscle. Make an opening with a sharp pointed scalpel through the entire thickness of the abdominal wall from the aponeurosis, located about an inch external to the abdominal incision and about [illegible] inches above the pubes. Avoid injuring the vessels coursing in this vicinity.

Step 3. Pass through the stab wound thus made a pointed artery forceps. Pick up the ligature placed around each round ligament and by pulling on it, deliver the ligament onto the anterior surface of the aponeurosis. Release the suture. Fixate the loop of the round ligament on either side to the aponeurosis with interrupted chromic catgut sutures. (Fig. [illegible] a, b.)

Step 4. Close the abdominal wound in layers.

Comment. This is an excellent procedure which has withstood the test of time. The uterus is held easily in an anteverted position. The portion of broad ligaments necessarily pulled out with the round ligaments raises the tubes and ovaries into a higher position. Avoid too small an opening through which the ligaments are pulled. Postoperative swelling and constriction may cause necrosis of the ligament.

[illegible] MODIFICATION OF THE GILLIAM OPERATION

[illegible] modified the Gilliam operation as follows:

Step 1. The patient is placed in the Trendelenburg position.

Step 2. A four-inch median suprapubic incision is used.

Step 3.Guy sutures of catgut are placed through or under each round ligament.

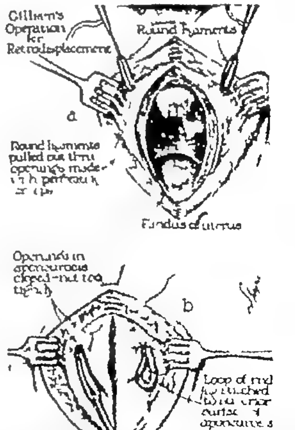


Fig. [illegible] Transperitoneal transplantation of the round ligaments. [illegible]

midway between their origin and out through the internal abdominal rings, and each suture is held by an artery forceps.

Step 4. The sheath of the rectus is opened on each side of the midline incision and by blunt dissection the rectus abdominis is gently separated from the under surface of the anterior rectus sheath.

Step 5. A blunt pointed, curved artery forceps is passed out under the fascia, above the rectus muscle, through the posterior termination of the sheath of the rectus to the outer aspect of the internal ring; with the abdominal wall of the corresponding side elevated, the inner aspect of the internal ring is made prominent by traction on the guy suture in the round ligament and the artery forceps is forced in through the internal ring under the peritoneum and on the upper surface of the round ligament, penetrating the peritoneum when well within the limits of the parietal peritoneum. The blades of the artery forceps are separated, the guy suture in the round ligament is grasped and drawn through the internal ring into the midline incision. Further traction brings the elongated round ligament doubled on itself through the internal ring over the upper surface of the rectus and along the under surface of the fascia to the midline incision.

Step 6. The double fold of round ligament is spread out in the shape of triangle and anchored to the under surface of the fascia with three catgut sutures, the apex at the cut edge of the fascia in the midline incision, the base looking outward toward the outer border of the rectus.

Step 7. The same steps are carried out with the opposite round ligament.

Step 8. The midline incision is closed in tiers, the apex of each round ligament being sewed together as the fascia is closed. No. chromic catgut is used to suture the round ligament; No. or No. chromic catgut for the peritoneum and fascia; dermal sutures are used for skin or stay sutures of silkworm-gut if desired. Care should be exercised to avoid tying the round ligament sutures too tightly, otherwise necrosis will result and pursuit of the round ligament being drawn back into the abdomen.

Postoperative care is the same as that in case of ordinary closed abdominal section, with rest in bed for two weeks following operation and the avoidance of severe physical exertion for a period of six weeks thereafter.

Posterior Implantation of the Round Ligaments

WEBSTER (AND BALDY) OPERATION

Step 1. Place the patient in the Trendelenburg position. Perforate the broad ligament on the right side with an artery forceps at a point close to the uterus under the ovarian ligament. (Fig. 1269 a.)

Step 2. Grasp the round ligament with an anatomic forceps at a point about one-third of the length of the ligament from the uterine end, where it is caught in the open jaws of the perforating artery forceps which seizes the ligament and draws it through the opening in the broad ligament to the posterior wall of the uterus. (Fig. 1269 b, c.) The round ligament on the left side is treated in a similar manner.

Step 3. Suture the loops of the round ligaments together and then attach them with interrupted catgut sutures to the posterior surface of the uterus.

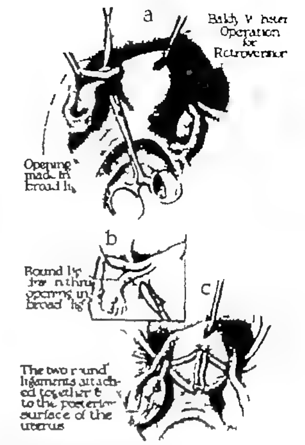


Fig. 1269. Webster-Baldy operation for retroversion of the uterus. a, A small opening made in the broad ligament and the round ligament drawn through. b, Method of drawing round ligament through the opening in the broad ligament. c, Attaching the round ligaments to the posterior surface of the uterus. [illegible]

Comment. The ligaments should be attached at the proper positions on the posterior surface of the uterus. If attached too low, the uterus may become retroflexed over the ligaments; if too high, anteflexion of the uterus may result. As little trauma as possible should be done to the peritoneum during the perforation of the broad ligament and suture of the round ligaments to the posterior surface of the uterus. If this precaution is neglected adhesion of contiguous structures (ovaries, bowel, etc.) may result.

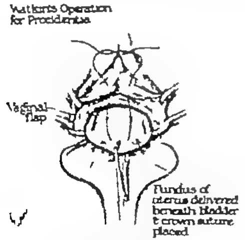


Fig. 1290. Watkins' interposition operation.

Interposition Operation

(WATKINS, [illegible])

The principle of this procedure is based on separating the bladder from the anterior surface of the uterus and transposing its attachments to the posterior uterine wall. The uterus is then placed in a position to support the bladder. Excess of vaginal wall is trimmed off and the vaginal wound closed. Follow with a perineoplasty.

Step 1. Separate the anterior vaginal wall from the bladder. Grasp the cervix with a volsellum forceps. Make a small incision in front of the cervix. Introduce a pair of blunt scissors and separate the vaginal wall from its attachments to the bladder or proceed as in anterior colporrhaphy (p. [illegible]). Gauze dissection completes the separation of the vaginal wall. Avoid injury to the bladder during this detachment.

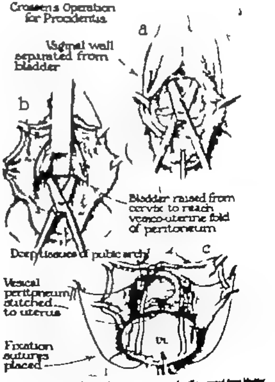


Fig. 1291. Crossen operation for procidentia uteri. a, Vaginal wall separated from bladder. b, Bladder raised from cervix to reach vesico-uterine fold of peritoneum. c, Method of attaching uterus by fixation sutures to the deep tissues of the pubic arch.

Step 2. Separate the bladder from its uterine attachment (intervesical ligament). Avoid separating the bladder too much laterally; separate it just sufficiently to permit the fundus of the uterus to be brought down after

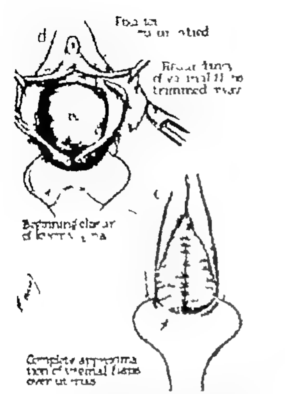


Fig. [illegible] (continued). [illegible] operation for prolapse.

opening the anterior cul-de-sac, through the vesico-uterine reflection. (Fig. [illegible].) Occasionally identification of this peritoneal fold is hard with some difficulty (adhesions). Once the peritoneum has been entered, the opening is enlarged laterally with the index fingers exerting lateral pressure.

Step 3. This consists of delivering the fundus uteri. Introduce an appropriate retractor between the bladder and uterus displacing the former upward, out of the way. Engage the fundus uteri in volsella forceps, pull it downward and forward. In so doing the cervix rises upward and is carried backward. The fundus is delivered through the wound.

Step 4. Place the retaining sutures as shown in Fig. [illegible]. The vesical peritoneum is sutured to the posterior surface of the uterus. This shuts off the peritoneal cavity and the operation is now completed in an extraperitoneal manner.

Step 5. Simple attachment of the fundus to the vaginal mucous membrane gave rise to recurrences (prolapse of the interposed uterus, return of the fundus to its usual position). To obviate these drawbacks [illegible] uses two special buried sutures (Fig. [illegible]). These sutures fasten the fundus to tissues which have a dependable attachment to the pubic arch. These tissues are identified by traction with forceps. Different tissues are caught and pulled upon until some are found which have the required attachment and then the special sutures are placed. These sutures are securely buried when the vaginal flaps are brought over. They fasten the fundus since they resist both upward and downward displacement.

While it is important to superimpose the entire bladder on the uterus, the latter must not be placed so firmly against the urethra as to interfere with urination.

Step 6. Closure of the vaginal wall is now completed by uniting the edges of the vaginal incision over the anterior surface of the uterus with interrupted sutures. Before doing this, redundant vaginal mucous membrane is trimmed off.

Step 7. Complete the operation by a well executed perineorrhaphy (p. [illegible]).

Comment. The operation should never be done in the child-bearing period; when indicated during that time, the patient should be sterilized during the operation (partial salpingectomy, etc.). Some surgeons excise the anterior lip of the cervix on general principles. A very large uterus should not be transposed without removing a portion of the fundus. Hypertrophy of the cervix should be remedied by amputation of the cervix. Transposition of the uterus is well adapted to instances after the menopause accompanied by marked cystocele without much prolapse or enlargement of the uterus.

MYOMECTOMY

Vaginal Myomectomy

Historical Notes. [illegible] performed this operation in [illegible]. Hysterotomy (simple incision of the uterus) was practiced and described by [illegible]. Myoma enucle-

[illegible]

ation was practiced in England and America by [illegible] and [illegible] in [illegible]. [illegible] in Germany.

Step 1. Lithotomy position, general or spinal anesthesia. Seek the pedicle of the tumor with the finger; if attached high up it may be engaged in a long curved forceps.

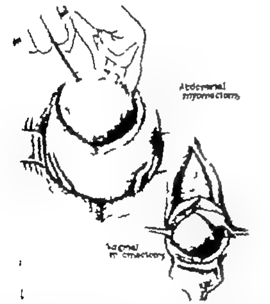


Fig. [illegible]. Abdominal myomectomy ... vaginal myomectomy. [illegible]

Step. The pedicle is clamped and the clamp is left on for about 48 hours after which it is cautiously removed. This procedure is applied to submucous pedunculated myomata projecting from the cervix. The myoma may be better exposed by hysterotomy through anterior division of the cervix, removing the pedicled tumor and suturing the pedicle. (Fig. [illegible].)

Comment. Myomata of the fundus may be enucleated as illustrated in Fig. [illegible].)

Abdominal Myomectomy

Step 1. Expose the uterus through a [illegible] abdominal incision.

Step 2. Engage the uterus in volsella forceps.

Step 3. Incise the wall of the uterus parallel to its axis and over the most prominent part of the tumor. Carry the incision down to the tumor.

Step 4. Insert a myoma screw into the tumor mass which is pulled out of the wound while in the uterus.

Step 5. Blunt dissection aided by sharp snips here and there usually enables enucleation of the tumor. Avoid injury and crushing of the uterine wall. (Fig. [illegible].) If the base of the tumor is broad, accomplish its separation from the uterine wall by sharp dissection. Thorough hemostasis at the base of the tumor which usually bleeds freely is essential (ligatures properly placed).

Step 6. Obliterate dead spaces. Close the wound in the uterus.

Step 7. Cover the line of suture with an omental graft.

Step 8. Close the abdomen in the usual manner.

OPERATIONS ON THE UTERINE ADNEXAE

SALPINGOSTOMY—STOMATOPLASTY

The object of this operation is to make an artificial ostium in the Fallopian tube. (Fig. [illegible], Martin.)

Step. Free the tube from adhesions. Hemostasis must be perfect; this is of utmost importance for if blood is permitted to remain in the neighborhood of the fimbria, adhesions will form again and thus frustrate the very object of the operation.

Step 2. Pick up the [illegible] with a pair of forceps and put the tube on the stretch. Incise an occluded end.

Step 3. Pass a probe along the lumen of the tube toward the uterine ostium, making sure that no strictures are present; if present, dilate them.

Step 4. Insert a pair of fine pointed scissors and split open the upper border of the fimbriated end of the tube for about an inch and a half.

Step 5. Insert sutures at each end of the incision to be used as tractors while the mucous membrane of the opened end is sutured to the muscular wall of the tube with fine catgut sutures. The operation may be performed on both tubes.

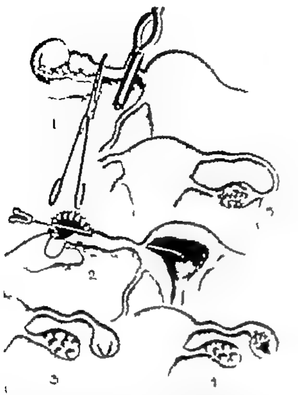
Comment. [illegible] was first to do a salpingostomy. Others followed.[illegible]

Both operations may be lateral or terminal. In the lateral salpingostomy ([illegible]) an oval [illegible] of the tube is done and the mucous membrane of the tube sutured to the peritoneum. (Fig. [illegible], 3 and 4.)

The terminal salpingostomy described above was first introduced by Martin. (Fig. [illegible].)

[illegible] devised an operation which he called "salpingo-ovaro-synthesis." This consists of resecting a portion of the ovary and then fixing the fimbria of the tube to the resected ovary as shown in the illustration. (Fig.

[illegible]



[illegible]

1973, 2) Gurming, Dellet, Martin and others have reported pregnancies following these operations.

For complete cornual tube, it must be mentioned that Vulal devised sal-pingoplasty on the stenosed tube which is comparable in principle to pyloroplasty.

SALPINGECTOMY

Removal of the Fallopian tube leaving the ovary behind

Step 1. With an artery forceps grasp the mesosalpinx between the fimbriated end of the tube and the ovary.

Step 2. Another appropriate forceps engages the uterine end of the tube proximal to the tubal isthmus.

Step 3. Remove the tube by cutting through the mesosalpinx with scissors or sharp scalpel (Fig. 1974).

Step 4. A deep wedge of uterine tissue carrying the uterine extremity of the tube is removed.

Step 5. Hemostasis. Often salpingitis isthmica nodosa is encountered. In order to frustrate its effects the isthmus of the tube must be removed. Catgut sutures (interrupted or continuous) close the wound. (Fig. 1974 b.) Perfect peritonealization should be the aim.

SALPINGO-OOPHORECTOMY

Removal of the Fallopian tube and ovary

Step 1. Clamp the infundibulopelvic ligament.

Step Apply another clamp to the uterine end of the tube, as in the previous procedure; have the first clamp is applied underneath the ovary.

Step 3. Both tube and ovary are excised with curved scissors. (Fig. 1975 A.)

Step 4. Ligate doubly the ovarian vessels in the infundibulopelvic ligament.

Step 5. Cut off the blood supply to the round ligament by ligating it; doubly ligate the uterine supply in the adjacent broad ligament. Make sure that hemostasis is perfect. Many a patient has paid with her life from neglect of ligating all vascular bundles. Leave nothing to chance. Look and make sure.

Step 6. Peritonize the raw area left by the removal of the adnexa. An interrupted suture tends to obliterate raw surfaces. A through-and-through suture embracing the entire thickness of the broad ligament and approximating the stump of the infundibulopelvic ligament to the raw surface at the uterine tubal stump is very effective (Fig. 1975 B).

Step 7. Close the abdomen in the usual manner.

Comment. It is advisable after salpingo-oophorectomy to suspend the uterus by one of the round ligament operations described above; this will avoid retroversion which frequently results following the operation. An Olshausen suspension serves the purpose well.

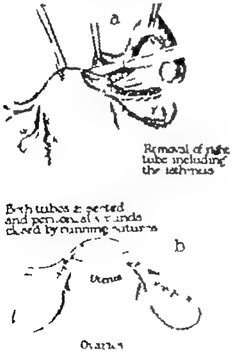
CONSERVATIVE OPERATIONS ON THE OVARIES

Resection of the Ovary

This operation is indicated only in cases when one follicle seems to be growing at the expense of the rest of the ovarian tissue, developing to become a large

[illegible]

retention cyst. The so-called "cystic degeneration of the ovaries" being considered a physiological process, resection of the ovary does not hold the important place in gynecologic operations as [illegible] years ago.



[illegible]

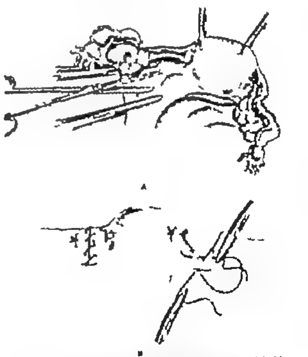
Step Expose the ovary.

Step 2. Place [illegible] clamp on the mesovarium. Tighten only sufficiently to cut off the circulation during the operative procedure.

Step 3. Circumscribe the cyst with the point of a sharp scalpel.

Step 4. Shell out the cyst.

Step 5. Attend to hemostasis in the bed of the ovary (fine catgut).



[illegible]

Step 6. Remove the clamp. Close the wound in the ovary with fine catgut sutures (interrupted or continuous). Safeguard against adhesion formation by careful coaptation of the edges of the ovarian tissue without tension.

Transplantation of Ovarian Tissue for Sterility and Endocrine Deficiency

Ovarian tissue has been transplanted to relieve vasomotor disturbances following the artificial onset of the menopause resulting from loss of ovarian tissue. In many cases of physiologic menopause accompanied by [illegible] disturbances, homotransplantation has, as I have shown elsewhere, distinct value. Following pelvic inflammatory processes sterility often results. In such instances the following procedure may prove of value. It has also been used in selected cases in sterility.

Step 1. Do a classical salpingectomy.
Step 2. Close the wound in the mesosalpinx with the exception of the wedge-shaped opening left in resecting the isthmus of the tube. Make sure that there is an opening from the tube into the uterine cavity; it must not be too large, it should admit only the point of the sound.
Step 3. Remove a slice of ovarian tissue about one-quarter of an inch thick and about the size of a thumbnail from one of the ovaries and put it into the opening at the uterine cornu. The implant should consist of the epithelial covering, cortex and medulla of the ovary. (Fig. 1976 a.)
Step 4. Cover the ovarian transplant with the superimposed structures. Do not strangulate the tissues. Use fine catgut interrupted sutures.
Step 5. Close the wound in the ovary with fine catgut.
Step 6. Repeat the same procedure on the other side. If only one ovary is present, the transplant is taken from it for both sides.

ESTES OPERATION FOR OVARIAN TRANSPLANTATION

When both tubes have to be removed and one or both ovaries remain, an attempt to transplant one of them may be undertaken.

Do a salpingectomy. Prepare the isthmic area as in the previous procedure. Remove a slice from the ovary as shown in the previous illustration. Keep in mind not to interfere with the blood supply of the ovary. Fold the ovary toward the isthmic denudation approaching it with its denuded surface. (Fig. 1976 b, c.) Cover the seat over with peritoneum, round ligament, etc.

Comment. The practicability of ovarian (auto-, homo- and hetero-) transplantation [illegible]

Historical Notes. Knauer in 1895 first successfully transplanted ovarian tissue from one site to another in the same animal. Such transplantation has been shown time and again to have definite indications and is a practical procedure in well selected cases. Following Knauer, Grigorieff, Cleveland, Bucura, Kehrer, Long and Evans performed successful autografts. Successful transplantations have also been reported by [illegible], [illegible], Sand, Marshall, [illegible], Lipschütz and others. Heterografts in animals were, as a general rule, failures. Morris in 1895 first successfully transplanted a piece of ovary into the stump of one tube. The author reported on the results of 60 cases of human ovarian transplantation. Morris and Bobery reported on 31 auto-transplants. The majority took but probably did not survive more than two or three years.

Comment. From a technical point of view, the site of implantation is

[illegible] Possibility of Ovarian Auto-, Homo- and Heterotransplantation with [illegible]
[illegible]
[illegible]

of importance. Thorough asepsis is essential on the part of both donor and recipient. Human ovarian tissue may be kept at a temperature varying from 0° to 1° and after 3 days be successfully implanted (Zondek-Wolff). Lipschütz and others believe that freezing injures ovarian tissue. My experimental work showed that after 48 hours' refrigeration the im-

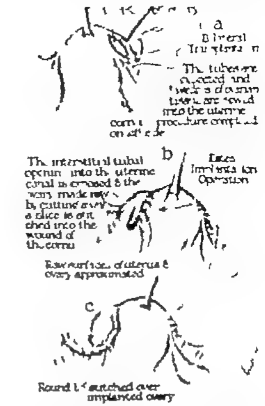


FIG. 1976. Transplantation of ovarian tissue into the horns of the uterus. b, Estes' implantation of the ovary into the uterus. The tube [illegible] implanted laying upon the uterus. The ovary [illegible] and the raw surfaces of ovary and uterus sutured together.

plant is of no value. As to the site, the labia majora, the broad ligament, suprapubic space, the rectus abdominus muscle just behind the sheath have all been made use of. My best results were obtained in menopausal syndromes and in various forms of ovarian dysfunction and following surgical castration. (Figs. 1977-1978.)

Suspension of Prolapsed Ovary

Historical Notes. The surgical treatment for this condition was first discussed severely by F. Dalsch, a pupil of L. Tait, in 1886, who called the operation [illegible]. Numerous operations have been devised for this procedure. Howard Kelly has on numerous occasions [illegible] and tightened the infundibulopelvic ligaments as a means of lifting [illegible] ovaries in which the ovary appears actually. An operation recommended by C. C. Barrows of New York, and adopted by Ward is performed as follows:

FIG. 1977. Human ovary transplanted into Macacus rhesus (monk). [illegible]

Step 1. Perforate the broad ligament of the mesosalpinx with an artery forceps, avoiding the blood vessels.
Step 2. Draw the ovary through the buttonhole opening thus created.
Step 3. Affix it in place with catgut sutures at each end.

Comment. Barrows and Ward point out that no disadvantages result from this procedure and that it

FIG. 1978. Left, Human ovary transplanted into Macacus rhesus (monk). [illegible] Right, Human ovary transplanted into Macacus rhesus. [illegible]

relieves the discomfort incident to the prolapsed ovary. It does not prevent pregnancy.

ACROHYSTEROSALPINGECTOMY

Blair-Bell-Beuttner Operation

[illegible]

The treatment of [illegible] inflammations offers some interesting [illegible]

Historical Notes. Propagation of inflammation via the uterus to the Fallopian tubes was studied by Astruc and Lombard in 1750 and 1758. Pelvic abscess was described by Bosset in 1773, lymphangitis by Aselius in 1627 and [illegible] in 1799. Phlegmons after delivery was shown to be an extension from the uterus [illegible] to the lower extremities, [illegible] (1823), [illegible] (1843), [illegible]. Extended studies of lymphatics were made by Albert (1830), [illegible], [illegible] (1839), Cruveilhier (1830), Velpeau (1830). In 1840 Nonat showed the presence of pus in the uterine lymphatics after labor. This was confirmed by Velpeau and Duplay in 1846. [illegible] in 1850 showed the relation between sterility and puerperal infection. Noeggerath in 1872 showed the relation of gonorrhea to sterility. Lucas-Championnière in 1870 stressed the role played by the lymphatics in parametrial inflammations. Oophorectomy was first done by MacDowell of Kentucky in 1809. Hegar in July 1872, and Battey in August of the same year, removed the first normal ovaries for the purpose of causing an artificial menopause to cure dysmenorrhea and nervous [illegible]. Hegar's [illegible]. He performed the same operation in 1876, by that time Battey's method had been popularized for a long period of time. In February 1872, Lawson Tait performed a unilateral oophorectomy for pelvic pain and later in the same year (August) he did his first oophorectomy for [illegible] of the uterus. He insisted on the importance of removal of both tubes and ovaries.

Acrohysterosalpingectomy aims at removal of both Fallopian tubes, the fundus of the uterus and one ovary. The object of the operation as Blair Bell's own phraseology is "no longer surgical justice with physiologic mercy." In view of the fact that in pelvic inflammatory disease the fundus of the uterus is always infected and is responsible for [illegible] and persistent [illegible] when only the tubes are removed, the rationale of the procedure becomes apparent. The conservation of one ovary and part of the uterus permits menstruation to continue.

Step 1. Place the patient in the Trendelenburg position. Open the abdomen.
Step 2. Free the tubes from adhesions. Pack off the intestines. Ample exposure is essential.
Step 3. Do a salpingo-oophorectomy on one side and a salpingectomy on the other with the difference that instead of excising only wedge-shaped portions of the cornua of the uterus, a [illegible] of the uterus through anterior and posterior incisions as shown in the illustration, is done. (Fig. 1979 a.)
Step 4. A wedge-shaped space with anterior and posterior flaps results. These are brought together with two rows of interrupted or continuous chromic catgut sutures. (Fig. 1979 b.) It is important to leave behind sufficient endometrial tissue to carry on the menstrual function.
Step 5. Unite the mesosalpinx and the other raw surfaces as indicated in describing salpingectomy and salpingo-oophorectomy. Bring the surfaces of the broad ligaments neatly together.
Step 6. Implant the round ligaments on the newly formed uterine top.
Step 7. Suspend the ovary to prevent its prolapse into the space of Douglas.
Step 8. Close the abdomen.

VAGINAL DRAINAGE OF AN ABSCESS OF THE CULDESAC OF DOUGLAS

The important factors to be considered in vaginal drainage are: (a) To avoid injury to the structures surrounding the abscess cavity and (b) to effect thorough drainage.

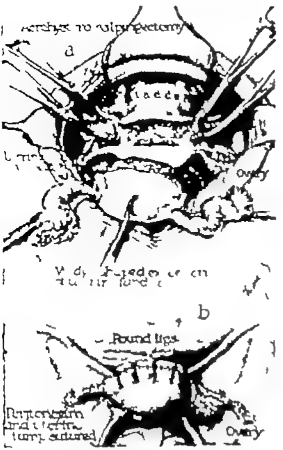


Fig. [illegible]. [illegible]

Step 1. Determine with the patient anesthetized, by means of [illegible] examination, the size and position of the purulent accumulation and particularly its point of fluctuation, if any.

Step 2. Introduce an Auvard or other form of vaginal retractor to keep the posterior vaginal wall taut. Grasp the posterior lip of the cervix with vulsellum forceps and pull it forcibly upward, thus exposing the posterior vaginal vault. Introduce the left index finger as high up in the vagina as possible, the back of the index finger holding the rectal wall out of harm's way. Into the right hand introduce a curved, closed pair of scissors along the palmar surface of the fingers, between it and the posterior surface of the cervix. It is made to enter bluntly or sharply divide the vaginal mucous membrane with a scalpel.

Step 3. Remove the parietal retractor and introduce one or both index fingers into the opening thus made and enlarge it. The dissecting finger separates the connective tissue upward keeping close to the posterior cervical wall. The closed scissors are an aid in locating and entering the abscess cavity.

Step 4. Enter the abscess cavity bluntly if possible, by perforating its wall. If too dense, sharp scissors dissection may be used. Avoid entering the rectum. A fecal mass must not be mistaken for the abscess. If in doubt leave the dissecting scissors in situ and have an assistant control the advance of the instrument with his finger in the rectum. Once the scissors have entered the abscess cavity open and withdraw the instrument with its blades opened. (Fig. [illegible].) Introduce a finger into the abscess cavity and explore for secondary pus pockets. Do not mistake a knuckle of bowel for such pocket. Be gentle in the exploration. Do not perforate the wall of the granulating tissue limiting the abscess cavity.

Step 5. Introduce a large size drainage tube into the cavity. (Fig. [illegible] b.) Pack the vagina lightly with iodoform gauze. A large size de Pezzer catheter may be used to advantage here. The tube is permitted to remain for from two to six weeks or until the abscess cavity is practically obliterated. It is better to leave a tube longer than depicted in the illustration.

Comment. Never irrigate a recto-uterine abscess cavity. It is unnecessary and may produce a great deal of harm. If the tube slips out it should be reintroduced.

ARTIFICIAL INSEMINATION

Indications. Where it is impossible for the semen to be deposited in the vagina (hypospadias, urethral fistula and impotentia coeundi).

The technic is simple. The necessary instruments consist of a special syringe with a long nozzle about the size of a uterine sound, a good speculum and vulsellum. A fresh specimen of semen in a rubber condom should be at hand.

Step 1. Place the patient in the lithotomy position. Introduce the speculum; grasp the cervix with a vulsellum forceps.

Step 2. Render the vagina and cervix dry with aseptic cotton pledgets.

Step 3. Insert the nozzle of the syringe filled with semen through the os and into the uterus. Avoid touching the vaginal walls. Inject the semen slowly and withdraw the syringe carefully. Let the patient remain in bed for a day with hips elevated.

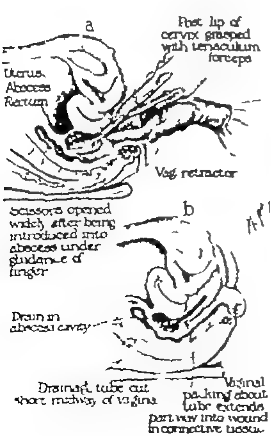


Fig. [illegible]. Drainage of abscess in cul-de-sac of Douglas. [illegible]

Comment. Insemination should be practiced according to Ogino-Knaus during the so-called fertile period. This can be determined in terms of the preceding menstruation only if the menstrual period is absolutely regular. Inasmuch as the onset of the next menstruation cannot be determined in irregular periods, a formula has been devised which takes into account the irregularity and permits the date of the last period to be used.

Fertile period lies between 10 + minimum days of cycle − 28
7 + maximum days of cycle − 28

For example—the period is regular each 28 days

$$10 + 28 - 28 = [illegible]$$
$$7 + 28 - 28 = [illegible]$$

That is, the fertile period lies between the [illegible]th and the [illegible]th days after the first day of the preceding menstrual period. If the period started on Sept. 3, the fertile period would start on Sept. 13, and end on Sept. [illegible].

If the periods are irregular, a definite knowledge of the variations is needed (for purposes of conception control, variations of more than [illegible] days in the length of the cycles render the method too uncertain to be of use). Suppose the shortest period is 26 days, the longest 30 days.

$$10 + 26 - 28 = 8$$
$$17 + 30 - 28 = [illegible]$$

The fertile period lies between the 8th and the [illegible] days after the previous menstruation—or using the same data as above, from Sept. 11 to Sept. [illegible].

This does not mean that all these days are fertile—but that investigation has proved that the ovary may discharge its ovum at any time within [illegible] days after and up to two days before the end of the fertile period. The two days which are added before and after the actual possibilities of ovulation are added because of the known possibility of the spermatozoa living 48 hours within the genital tract, i.e., a lapse of 48 hours between coitus and ovulation might still result in impregnation.

STERILIZATION

Sterilization in the female may be produced either by the means of x-ray or surgery. After thorough dilatation and curettage, the ostia of the Fallopian tubes may be electrocoagulated. Occlusion by chemical means may be resorted to by using escharotics such as zinc chloride which results in atresia of the interior of the uterus. Surgical means employed for sterilization are the following:

(a) Picking up the mid-portion of each Fallopian tube, ligating the tube in two places and dissecting the central portion. F. Brooke Bland stresses the importance of using absorbable sutures in ligating the tube.

(b) The following operative procedure may also be resorted to:

Step 1. Make an incision about ½ inch long through the anterior layer of the broad ligament.

Step [illegible]. Insinuate a curved forceps through this opening and separate the tube for a short distance in the broad ligament.

Step 3. Cut off the fimbriated end of the tube. Ligate the stump.

Step 4. Pass a ligature through the ligated stump and tie the ligature about its middle.

Step 5. Pass the needle through the opening made in the broad ligament and pull with it the tube. The other half of the catgut suture is left long and armed with a needle. Pass this half of the suture similarly and ligate the two ends of the catgut, thus obliterating securely the opening of the tube.
Step 6. Close the opening in the broad ligament with a few fine catgut sutures.

OPERATIONS ON THE PREGNANT UTERUS

CESAREAN SECTION

Classical, Conservative Operation

A hypodermic injection of a preparation of ergot is given into the muscles of the thigh about ten minutes before the operation is begun. This will aid the contraction of the uterus thus minimizing the danger of hemorrhage.

One ampule of pituitary extract is injected into the uterus immediately after the child is delivered. A second ampule of ergot may be administered just before the patient is returned to bed.

Where the patient is in labor at the time of operation, the ergot is administered only with the idea of limiting postpartum hemorrhage and may be postponed until the abdomen is opened.

Some surgeons recommend the injection of pituitary extract alone into the uterine muscle immediately before incising it.

Care should be exercised while the incision is being made not to injure the intestines or the bladder, which lie in close proximity to the uterus. To cut the infant while the incision is being made is a reflection on the surgeon's preparedness and skill.

Step 1. The incision may be made either above or below the umbilicus unless an extraperitoneal operation is planned when a low incision is made. The long incision, practiced long ago, which extends from the ensiform cartilage to the pubes and which permits of the free delivery of the uterus from the abdominal cavity after which it is incised, has been discontinued by the majority of surgeons. At the present time the incision is made just long enough for delivering the infant easily, the uterus being opened in situ. If infection is present, the uterus is delivered before it is incised and the abdominal cavity is protected by gauze packing. The uterus should then be amputated to prevent the infection from spreading throughout the peritoneal cavity (Porro operation).

Surgeons who recommend the high incision claim that it prevents the formation of adhesions between the uterus and abdominal incisions and also avoids incisional hernia. Its chief objection seems to be in the fact that if it becomes necessary to deliver the uterus before it is incised, the abdominal incision must be enlarged considerably. It is, however, quite desirable, in obese patients, to resort to a lateral incision. The low incision has many advocates; however, I fail to see any particular point of superiority in its use.

An incision to the right of and falling about midpoint of the umbilicus will serve its purpose well. It should be about ten inches long (Fig. [illegible]). In the majority of cases the uterus is rotated somewhat to the right, thus the incision falls over the site of the uterus to be incised.

As often seen practiced, Cesarean section is responsible for more hurried motions in the operating room than any other procedure; yet it is quite unnecessary to work any faster here than in any other laparotomy with the exception of the period from the incision into the uterus to the delivery of the child, the purpose being to avoid the loss of much blood.

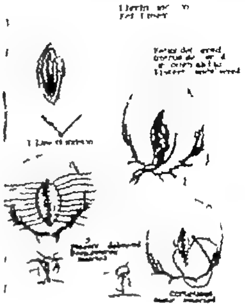


Fig. [illegible]. Classical (conservative) cesarean section.

Step 2. Ascertain the position of the uterus and child by palpation and if rotated considerably to the side, attempt to rotate it manually to the normal position.
Step 3. If a Porro operation is contemplated, protect the abdominal cavity with gauze packs wrung out of normal salt solution and proceed as described under Porro Cesarean Section, p. [illegible]. If the case is clean, protect the peritoneum from escaping amniotic fluid and blood by pressing the walls of the abdomen against the uterus.
Step 4. Incise the wall of the uterus longitudinally exactly in the midline down to the placenta if that is located on the front. The incision should be of sufficient length to permit easy delivery of the child. Do not become alarmed

if bleeding is free from the uterine sinuses; it will stop as soon as the uterus begins to contract. If the placenta lies right under the incision in the anterior wall (a) either push it aside if that can be accomplished with ease, or (b) proceed right through it with firm pressure of the right index finger. Open the membranes.

Because the placenta is immediately beneath the incision need not cause concern. Go right through it. Of course, the bleeding will be more profuse than otherwise but this is of no moment. Once the membranes have been perforated, simply pass the hand into the uterine cavity, search for a foot of the child, deliver it to the surface, deliver the other foot. Deliver the arms, extract the body and deliver the head of the child.

Step 5. Clamp the cord in two places and cut it between the clamps. Give the baby to an assistant who waits with a warm blanket and will take further care of the newborn.

Step 6. Deliver the uterus through the incision in the abdomen, protect the peritoneal cavity from contamination with lap sponges or sterile towels. Remove the placenta and all of the membranes, especially those in the lower uterine segment which if left behind will obstruct the cervical canal (Fig. [illegible]).

Step 7. Close the incision in the uterine muscle with interrupted sutures of chromic catgut embracing all the layers except the mucosa, being careful not to tie them too tightly (Fig. [illegible]). Secure proper approximation by continuous sutures placed superficially. Interrupted linen sutures have served me well.

Step 8. Remove the lap sponges from the abdominal cavity, mop up any amniotic fluid or blood which may have escaped into it, and close the abdominal wound in layers.

Comment. The only time the child is in danger during Cesarean section is during the interval between the incision of the uterus and the delivery of the infant, particularly in instances where the placenta must be detached from the wall of the uterus before the hand can be inserted into the uterine cavity. This is the only step in the operation where unusual speed is justified.

Forty years ago French advocated the adoption of a transverse fundal incision based on the idea that since the vessels of that area run mostly transversely, the large ones are less likely to be injured. The results following this procedure were very satisfactory but were no better than those obtained by the present-day method. The classical method offers more protection against adhesions and infections than this method.

In cases that have been a long time in labor vaginal preparation should be made before the abdominal operation is done. This is accomplished by thoroughly scrubbing the parts with sterile soap and water while the patient is under anesthesia. Antiseptic douches are not sufficient. Before closing the abdominal incision, any clots remaining in the uterus should be pressed out.

Compression of the broad ligament, while the incision is being made, is advocated and well practiced by some although it is wholly unnecessary

except on rare occasions. It has been observed that pressure exerted on the lower uterine segment, either by instrument or hands, seems to partially paralyze the uterine musculature, temporarily diminishing its contractility thus interfering with normal contraction and retraction.

No matter what method of suturing of the uterine wound is resorted to, the important factor is to accomplish that step of the operation thoroughly, safeguarding the suture line against leakage.

Two-flap, Low-incision Cesarean Section

Alfred C. Beck uses two-flap low incision cesarean section which is a modification of the Krönig technic. Beck maintains that the usual source of peritonitis through the uterine wound and the classical course is that of a puerperal infection followed by a sudden development of peritonitis due to leakage into the peritoneal cavity. Placing the incision in the lower uterine segment and doubly sealing it with bladder and flaps of peritoneum affect a two-fold barrier against the usual mode of extension of infection from the uterus to the peritoneum. Within a short time after operation, these flaps become adherent and make the wound extraperitoneal. Should infection supervene the flaps are sufficiently sealed so as to protect the peritoneal cavity from contamination. Such cases [illegible] thus limited to the subperitoneal tissues from which drainage occurs spontaneously either through the lower angle of the abdominal wound or through the separated edges of the uterine wound into the cervix and vagina.

Although the low cervical Cesarean section is somewhat more difficult than the classical operation it gives excellent results, and is the procedure of choice whenever Cesarean section is performed six or more hours after the onset of labor. If however the patient shows signs of actual infection, as indicated by elevation of temperature and rapid pulse, much better maternal results are obtained if the body of the uterus is amputated by a Porro operation.

Step 1. Place the patient in the Trendelenburg position. Catheterize. Make a midline incision beginning immediately below the umbilicus; extend it to the symphysis pubis (Fig. [illegible]).
Step 2. Expose by adequate retraction of the wound edges, the lower uterine segment, the bladder and its uterine reflection, about [illegible] cm. above the bladder. Cut the peritoneum transversely for about [illegible] cm. If the single incision or hysterotrachelotomy technic is followed, dissect away the upper margin of the stretched peritoneum sufficiently for adequate exposure of the lower uterine segment and proceed with the subsequent steps (Fig. [illegible]). If the two-flap operation is followed, the peritoneum is picked up about [illegible] cm. above the lower transverse incision and is freed about [illegible] cm. on each side of the midline. The dissection of this upper flap is carried out like the [illegible] of the lower flap; this is a little more difficult. The object [illegible] this flap far enough to expose the upper part of the lower [illegible]. If the patient is in labor all the dissection [illegible] line of firm attachment between the [illegible] in labor it is better to make the upper flap
Step 3. Traction sutures are introduced at

Exposure of the lower uterine segment shows the lower and upper flaps between which is a 1 cm. bridge of undisturbed peritoneum. A DeLee retractor is placed under the bladder flap to protect it from injury. The abdominal cavity is well walled off with lap sponges. The lower uterine segment is opened by a longitudinal incision which is started below the retractor in the midline and is continued upward toward the upper retraction suture. If blood and amniotic fluid obscure the field, the incision is continued by touch. Suction should be used for the removal of the blood and amniotic fluid (Fig. 1982[3]).

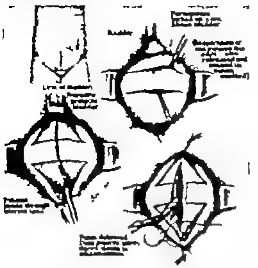


Fig. 1982. Low cervical section. (Alfred C. Beck, two-flap technic.)

Step 4. By means of a finger in the mouth, the head of the child is rotated until the face comes to occupy the uterine incision. Then the delivery is effected by means of a short pair of forceps with the concavity of its blades facing the pubis, or by passing the hand under the occipital region, aided by pressure upon the fundus of the uterus. The cord is severed and the child is handed to an assistant. The nurse injects 1 full cubic centimeter of obstetrical pituitrin into the deltoid muscle just before the child is born, and after its delivery the placenta is expressed or removed manually. Then another *full cubic centimeter of pituitrin is again injected into the same place.* Some surgeons inject the pituitrin into the uterine muscle. While waiting for the placenta to separate, deep interrupted chromic catgut, No. 1,

single strand sutures may be introduced down to the endometrium. These sutures are placed about 1 cm. apart (Fig. 1982[ ]).

Step 5. Pull on the two traction sutures lifting the uterus against the abdominal wall and facilitating the introduction of the interrupted chromic catgut sutures. Immediately after the placenta is removed the uterus is closed by pulling on the clamps which hold the deep sutures (Fig. 1982[5]).

Step 6. The deep sutures are tied and the wound is made more secure by inserting a second series of interrupted chromic No. 1 single strand catgut sutures. These are introduced midway between the deep ones and pass

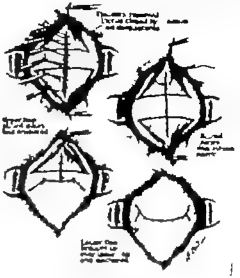


Fig. 1982 (continued). Low cervical section.

through the tough surface connective tissue and most of the thickness of the uterine wall (Fig. 1982[6]).

Step 7. The lower flap is now pulled up over the bridge of undisturbed peritoneum and is anchored by two chromic No. 1 single strand sutures (Fig. 1982[7]).

Step 8. The lower flap is brought up over the upper one and is attached by five chromic No. 1 single strand interrupted sutures, after which *a continuous suture reinforces the attachment and turns in the cut edges of peritoneum.* After a short time the uterine wound becomes extraperitoneal as a result of adhesion of these flaps (Fig. 1982[8]).

Porro Cesarean Sections Under Local (Infiltration) Anesthesia

J. P. GREENHILL'S TECHNIC

J. B. DeLee pointed out in 1915 the feasibility and advantage of performing cervical Cesarean section under local (infiltration) anesthesia. However, as far as Greenhill could learn, no one has described Porro Cesarean section (supravaginal hysterectomy after Cesarean section) under direct infiltration anesthesia.

Although 6 to 8 ounces of the anesthetizing solution is the usual amount used in administering a local anesthetic for a Porro Cesarean section, 10 ounces of solution is generally prepared—0.5 per cent procaine hydrochloride, to which, after sterilization, 5 drops of 1:1000 epinephrine are added for each ounce of procaine solution.

In a series of 41 operations performed by Greenhill, the average amount of anesthetic solution used was about 6 ounces and for the average Porro approximately 8 ounces.

Step 1. While the skin is being injected, the patient is given ¼ grain of morphine sulphate and 1/100 grain of scopolamine. A low midline incision is made. Injection of procaine hydrochloride solution is begun at the upper point of the planned incision. A fine needle is used to form the first wheal as it is less painful. After that a larger needle is inserted into the puncture point made by the first one. Injections of procaine hydrochloride are made into and under the skin down to the symphysis pubis. Besides being injected in the midline, injections of the solution are made for a distance of about 3 cm. on either side of the midline down to the pubis. Procaine hydrochloride is used generously here to overcome the natural sensitiveness of the tissues. Keeping the needle constantly in motion while injecting the solution prevents it from entering the blood vessels.

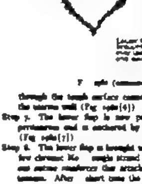
Step 2. Wait four or five minutes for the anesthetic to act. Make an incision through the *skin and adipose tissue with a sharp knife. Anesthetize the* anterior rectus fascia as well as the rectus muscle, using another needle. After the anesthetic has had time to become effective, incise the fascia with a new knife and divide the rectus muscles in the midline.

Step 3. Desensitize the posterior rectus fascia and the parietal peritoneum for about 4 cm. on each side of the midline. Generous injections are made over the bladder and into the space of Retzius. Open the peritoneal cavity. Expose the reflection of the bladder peritoneum over the lower uterine segment and raise it up with tissue forceps. Inject about ½ or 1 ounce of procaine hydrochloride under the loose peritoneum (Fig. 1983); spread the solution with the finger under the bladder and into the broad ligaments (Fig. 1984). Plenty of solution should be used so that it can be pressed into the broad ligaments in an outward, upward and downward direction. No more anesthetic is administered until after delivery.

Step 4. Make a transverse incision in the bladder peritoneum as if a cervical Cesarean section is being done. Strip the bladder as far down as is deemed necessary. Make a vertical or transverse incision, preferably the former, in the lower uterine segment. Deliver the child either manually or by means of forceps. Remove the placenta; close the uterus.

J.A.M.A., March, 1935.

Step 5. If a Porro operation is being performed, make a transverse incision in the peritoneum of the bladder; strip it down a short distance. A transverse incision in the lower uterine segment is preferable here to a vertical incision and it is made close to where the body of the uterus joins the lower uterine segment (Fig. 1984). Point the ends of the incision upward toward the round ligaments. The transverse incision is chosen here because it renders extensive stripping of the bladder unnecessary, and because the amputation



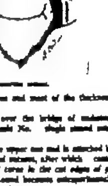


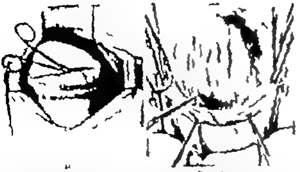
Fig. 1983. Fig. 1984.

Fig. 1983. Exposure of field for Porro cesarean section under infiltration anesthesia. The solution of procaine hydrochloride is injected at one spot beneath the peritoneum which loosely attached to the lower uterine segment. A retractor is left in the bladder to prevent its ...

Fig. 1984. With a finger the procaine hydrochloride solution under the loose peritoneum gently pushed down under the bladder and well out into the broad ligaments, upward and downward. (Courtesy, Dr. J. P. Greenhill.)

can be done by continuing this transverse incision to the posterior wall of the lower uterine segment, and also because it makes unnecessary the suturing of a vertical incision in the cervical stump along with the transverse circular one.

Step 6. After delivering the baby, clamp the cut edges of the uterus temporarily (Fig. 1986). Leave the placenta, cord and membranes in the uterine cavity. Carefully lift the uterus out of the abdominal cavity. Inject both procaine hydrochloride solution subperitoneally on the posterior wall of the uterus along the line of amputation from one broad ligament to the other. Ligate the round ligaments doubly, clamp them proximally and divide between the clamp and ligature. Apply long clamps to the broad ligaments close to the uterus (Fig. 1986). Leave the adnexa unless their removal seems especially indicated.



[illegible]

[illegible]

Step 7. Incise the broad ligaments between the clamps down to the level of the transverse incision in the lower uterine segment (Fig. 1979). After checking to see that the uterine arteries are clamped, continue the original transverse incision in the lower uterine segment all around the uterus completely amputating it. Doubly ligate the uterine arteries. Ligate the broad ligaments with figure-of-eight sutures. It is permissible to ligate the broad ligaments and uterine arteries without previously clamping them.

Step 8. Suture the edges of the lower uterine segment, attach the round and broad ligaments to it; the liberated peritoneal flap of the bladder is sutured over the entire area (Fig. 1980). Proceed to close the abdominal wall as in any laparotomy.

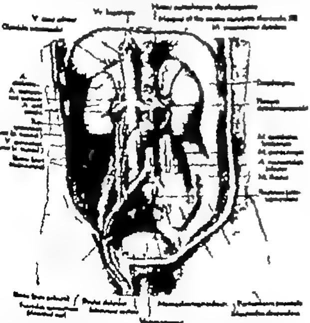
All pulling and tugging should be avoided while performing this operation under local anesthesia. If abdominal pads are deemed necessary they may be placed without discomfort to the patient.

CHAPTER 40

SURGERY OF THE GENITO-URINARY ORGANS

OPERATIONS ON THE KIDNEYS

Anatomic Considerations. [illegible]



[illegible]

Relations of the Kidney

		Right Kidney	Left Kidney
Anterior—	[illegible]	[illegible]	[illegible]
Medial—	[illegible]	[illegible]	[illegible]
Lateral—	[illegible]	[illegible]	[illegible]
Posterior—	[illegible]	[illegible]	[illegible]

[illegible]

in turn is derived from the aortic and solar plexuses and the lesser splanchnic nerve. The renal plexus is closely associated with the spermatic plexus in the male, with the sympathetic ganglia supplying the [illegible] and bladder, and with the upper lumbar nerves, [illegible] accounts for the [illegible] pain, the [illegible] and [illegible] [illegible] and the lumbar [illegible], so frequently observed in affections of the kidney.

The Ureters and Pelvis of the Kidney. The ureter (Fig. [illegible]) is about 10 inches in length and begins in the hilum of the kidney in [illegible] known as the pelvis of the kidney. It passes downward on the posterior surface of the abdominal wall and entering the pelvis terminates in the posterolateral angle of the urinary bladder. The pelvis of the kidney is pyramidal in shape; its base is directed

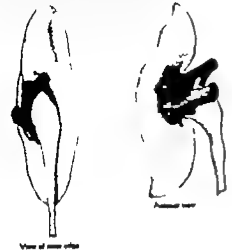


Fig. [illegible]. The right kidney, showing the relations of the pelvis and blood vessels. (Applied Anatomy, Davis.)

toward the renal sinus, its apex pointing downward. Its base is divided into major and minor calyces, the former are usually three in number, occasionally [illegible] only [illegible]; the minor calyces vary in number. The capacity of the renal pelvis varies but is usually from [illegible] cc. In hydronephrosis the capacity is greatly augmented. The abdominal portion of the ureter is retroperitoneal and lies on the psoas muscle. It courses downward toward the sacro-iliac joint and crosses the common iliac vessels just above the origin of the external and internal iliac arteries. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] vessels and the parietal attachment of the pelvic mesocolon. The pelvic portion of the ureter lies against the lateral wall of the pelvis in the retroperitoneal tissue. It passes downward and forward, lying on the obturator internus muscle, the obturator vessels and nerve, the inferior vesical and middle hemorrhoidal arteries, while posteriorly to it lie the hypogastric artery and the sacral plexus. It courses from the spine of the ischium to the posterior surface of the bladder being crossed above, before its termination, by the vas deferens. In the female, after crossing the common iliac ves-

sels, it courses downward and forward, passing beneath the base of the broad ligament at this point. It is crossed above by the uterine artery. Before entering the bladder it is in close relation above and laterally with the walls of the vault of the vagina.

Fig. [illegible]. Course and relations of the ureter. (Davis, Applied Anatomy.)

METHODS OF EXPOSING THE KIDNEY

GENERAL CONSIDERATIONS

1. Lumbar extraperitoneal route.
2. Paraperitoneal route.
3. Abdominal, transperitoneal route.

Lumbar Route

Position of the Patient (Fig. [illegible]). The patient may be placed in the prone, lateral or semiprone position. If in the prone position, [illegible] large pillow [illegible] cushion or [illegible] covered [illegible] [illegible] small cushion should be placed beneath the abdomen. No matter what position is used the following conditions must be met in order to successfully expose the kidney:

1. The lumbocostal space must be made as wide as possible.
2. Respiration must not be permitted to become impeded.
3. The proper position of the patient must be maintained throughout the entire operative procedure without the aid of an assistant.

Body elevators on modern operating tables must be so constructed as to

exert pressure on the front of the abdomen, to push the kidney up into the lumbar wound. The adjustable kidney elevator when in operation with the patient on the sound side, exerts pressure between the costal margin and the ilium and will cause [illegible] marked lateral flexion and [illegible] correspondingly increased costo-iliac space in which the incision is to be made. It must be kept in mind that, [illegible] the wound is about to be sutured the elevator must be lowered.

Anesthesia may be local or general (Fig. [illegible]).

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Position for kidney operation.

Fig. [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] (After [illegible].)

Varieties of Incisions (Fig. [illegible]). [illegible] Vertical incision (Simon). [illegible] Transverse incision (Pean). 3. Oblique incision (Bergmann-Israel). 4. Trap-door incision (Bardenheuer).

The most popular and widely used is the Bergmann-Israel oblique incision or some modification of the same. It is carried out as follows:

Begin the incision on [illegible] level with the twelfth rib at the outer edge of the erector spinae muscle; continue it downward and forward to [illegible] point about [illegible] finger's breadth above the highest point of the iliac crest. The incision may terminate here or if need be, it may be extended forward toward the junction of the outer and middle thirds of Poupart's ligament (Fig. [illegible]). The length of the incision depends, of course, upon the nature of the operation to be performed and the size of the surgeon's hand. For ordinary exploration, an incision of [illegible] to [illegible] inches is sufficient. If necessary the incision is enlarged through the first muscle plane [illegible] the latissimus dorsi above and the external oblique below. Then through the second muscular plane—the internal oblique. Incise then the aponeurosis of the transversus muscle and the muscle itself beneath which the

transversalis fascia is found. A small opening is made into this fascia through [illegible] [illegible] finger is introduced as [illegible] guide and the fascia incised along the entire length of the wound. The quadratus lumborum now presents. Hold the ilio-inguinal and iliohypogastric nerves out of the way with the group of reclined muscles and the twelfth intercostal nerve with the anterior group. The quadratus lumborum may be either retracted toward the spine or incised, as needs be. After the

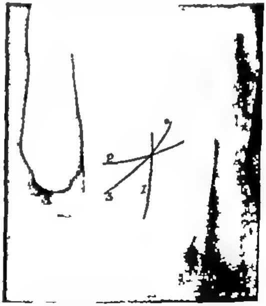


Fig. [illegible]. Incisions to expose kidney. [illegible] After Simon. [illegible] After Pean. 3. After Bergmann-Israel. (*) Position of twelfth rib.

transversalis fascia is incised the perirenal fat presents; this in turn through with the finger until the kidney is reached. Avoid, during the deeper dissection, injury to the pleura, should it descend below the twelfth rib.

In the presence of certain difficulties such as (a) firm adhesions, (b) very short pedicle of the kidney, (c) large kidney (tumor, etc.), W. J. Mayo suggested freeing the twelfth rib in order to gain additional exposure space. The posterior portion of the rib is turned upward and backward nearly to the articulation of the rib with the transverse process of the twelfth dorsal vertebra. Should

[illegible]

Fig. [illegible]

The [illegible] Route

[illegible]

Transperitoneal Abdominal Route

[illegible]

Fig. [illegible] Paraperitoneal nephrectomy

[illegible]

Fig. [illegible]

OPERATIONS ON THE KIDNEY

NEPHROPEXY—FIXATION OR SUSPENSION OF THE KIDNEY

[illegible]

Indications

1. [illegible]
2. [illegible]

[illegible]

Contraindications

1. [illegible]

[illegible]

Principles Underlying Nephropexy Operations

[illegible]

Step 1. [illegible]

Step 2. [illegible]

Step 3. [illegible]

Step 4. [illegible]

Step 5. [illegible]

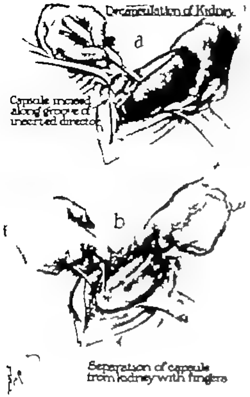


Fig. [illegible]. Edebohls' operation of decapsulation and suspension of the kidney. [illegible]

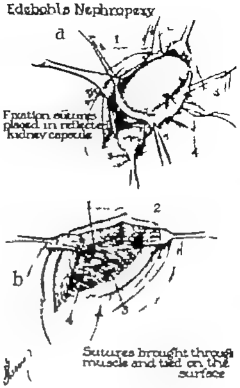


Fig. [illegible]. Edebohls' nephropexy and decapsulation operation. [illegible]

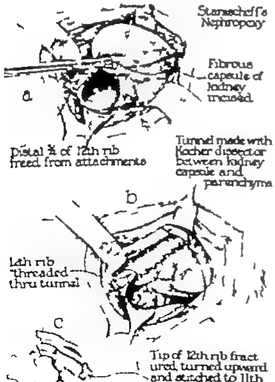


Fig. [illegible]. Staraschoff's nephropexy operation. [illegible]

strong suture about it and causing the formation of a hammock to support the lower pole of the kidney. The muscle and fascia are now closed by interrupted sutures. The previously placed sutures, outside the closed lumbar muscles, are now gently pulled upon thus bringing the decorticated surface of the kidney in contact with the quadratus lumborum; the sutures are now tied.

Step 6. Close the skin. Drain the wound.

Comment. Avoid kinking the ureter during the operation. The main principle of the operation is to bring a large area of decorticated kidney into contact with a corresponding area of quadratus lumborum.

Albarran's method consists of suspending the kidney to the last rib after its decapsulation and converting the capsule into flaps which are sutured to the rib.

Israel's method takes sutures through the parenchyma of the kidney; suspension is accomplished by attaching the kidney to the last rib, subperiosteally.

In Vogel and Bazsch method the twelfth rib is made use of as a direct support to the kidney by passing around the rib, flaps of the fibrous capsule.

STARASCHOFF'S NEPHROPEXY

In Starasch[illegible]'s clinic, among [illegible] operations between 1900 and 1934, there were 163 operations on the kidneys, and of these only [illegible] suspensions of the kidneys—7 per cent of all kidney operations. All other cases of floating kidney were treated conservatively (dietetic-orthopedic régime). The operation is performed as follows.

Step [illegible]. Bergmann-Israel incision. Open and retract the fatty capsule.

Step [illegible]. Make an oblique incision about 5 cm. long, parallel to the long axis of the kidney on its posterior surface in the region of the upper pole, somewhat mesially penetrating the fibrous capsule to the parenchyma of the organ. Make a similar incision through the fibrous capsule to the parenchyma, running parallel to, about midway and near the lateral border of the kidney as shown in the illustration (Fig. [illegible] a).

Step 3. With a Kocher director create a tunnel between these two incisions between the fibrous capsule and the parenchyma of the kidney.

Step 4. Insinuate the twelfth rib through this tunnel of the mobile kidney. A few sutures attach the kidney to the periosteum of the rib (Fig. [illegible] b).

Step 5. In order to avoid the suspended organ slipping off (coughing, muscular contractions, etc.), the tip of the twelfth rib is fractured about 4 cm. from its termination, is reflected upward and attached to the periosteum of the contiguous rib with catgut sutures. This effectively prevents the kidney slipping off (Fig. [illegible]).

Step 6. Restore the fatty capsule over the kidney and fractured rib. Attach the adipose capsule with a few sutures to the lumbar musculature.

Step 7. Close the wound without drainage.

Comment. Staraschoff emphasizes the following advantages of this method.

(b) Complicated incisions and flap formations of the fibrous capsule are not necessary—a simple tunnel between capsule and parenchyma of the kidney is all that is necessary.

(c) The kidney is not simply suspended but securely fixed to the twelfth rib; torsion of the kidney becomes impossible.

(d) The direction of the tunnel corresponds to that of the last rib, thus assuring [illegible] normal position of the kidney.

(e) The [illegible] displacement of the rib assures impossibility of the suspended organ slipping.

( ) The results were highly satisfactory (Fig. [illegible]).

Fig. [illegible]. Bronstein's nephropexy. Pyelogram two months after operation. Normal position of the suspended kidney. Arrow points to [illegible] point of twelfth rib. (Courtesy of Prof. Alexander Bronstein.)

Nephropexy Combined with Nephrolysis and Ureterolysis

O'CONOR'S OPERATION

Vincent J. O'Conor pointed out that important data obtained from careful study of [illegible] series of cases (cystograms, urétéropyelograms, history, etc.) establish definite indications and contraindications to the use of renal suspension. Comparing his personal experiences with those of others (Kelly, Kelsey[illegible]), O'Conor is partial to nephrolysis and ureterolysis combined with nephropexy which he performed in [illegible] series of selected cases with gratifying results.

O'Conor admonishes that to be successful, the operation "not only must include [illegible] proper replacement of the kidney in as nearly normal position as possible, but must also provide for [illegible] complete freeing of the kidney, kidney pelvis and ureter from surrounding attachments before the suspension of position is attempted."

Step [illegible]. An incision (Figs. [illegible]) is made which begins just below and parallel with the anterior half of the twelfth rib, from whence it is carried downward and forward for about five inches (Fig. [illegible]).

Step 2. Free the kidney in the usual manner. Incise its adipose capsule and clear the fatty tissue. Isolate the pelvis and ureter and carefully separate these from all surrounding attachments; the ureter is separated down to the bifurcation of the iliac vessels (Fig. [illegible]).

Step 3. Liberate the kidney and its pedicle freely from its attachments.

Step 4. Incise the true capsule of the kidney at its upper pole both anteriorly and posteriorly and reflect it carefully down to the region of the hilum. This should be done gently but some careful [illegible] its turn all with the capsule. In similar fashion the capsule is incised at its lower pole and reflected upward. A ribbon of true capsule about two inches in diameter is thus left attached at its original site surrounding the middle third of the kidney. The capsular layers are now overlapped so that three thicknesses of capsular tissue are available to receive the suspension sutures (Fig. [illegible]).

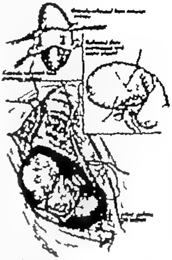


Fig. [illegible]. Overlapping of both upper and lower poles of kidney [illegible] so that three layers of capsule may be used to hold [illegible] sutures [illegible] left long enough to be carried above the twelfth rib. [illegible] (Courtesy of Dr. Vincent O'Conor.)

Step 5. A No. [illegible] chromic catgut continuous, U-shaped lock locking suture is now placed through the pleated capsular layers from the extremity toward the hilum, anteriorly and posteriorly. The ends of the sutures are left long to be anchored above the exposed portion of the twelfth rib. O'Conor lays emphasis on the fact that sutures placed as described have great tensile strength and will not separate the capsule from the underlying parenchyma of the kidney (Fig. [illegible]).

Step 6. Replace the kidney downward in the wound; enlarge the renal fossa by stretching it bluntly with warm, moist gauze packs. The posterior suspension sutures are now carried under and above the twelfth rib, as far toward the costovertebral angle as possible. This is followed by placing the anterior sutures, carrying them also under and above the twelfth rib, one or two inches in front of the suture from the posterior side of the kidney (Fig. [illegible]).

Step 7. Push the kidney up firmly beneath the diaphragm. Lower the elevating device of the operating table. While the kidney is being held in position, pull firmly on the sutures upward and tie them simultaneously above the rib. The remaining strands of all four sutures are tied again. [illegible]

of the decapsulated portions of the kidney will form to the diaphragm and psoas muscle. No further anchoring of the kidney is necessary.

Step 8. Close the wound as usual, without drainage (Fig. [illegible]).

Comment. In [illegible] series of cases (as up to 1936) operated on by O'Conor by this procedure, the results were gratifying. All patients were allowed

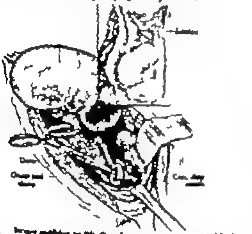


Fig. [illegible]. [illegible] twelfth rib to first portion [illegible] and forward. Kidney has been completely freed from all surrounding attachments [illegible] (Courtesy of Dr. [illegible] Conor.)

to sit up in bed fourteen days following the operation. No corsets or belts were used. Patients left the hospital in from sixteen to twenty days.

In discussing nephroptosis Bransford Lewis and Grayson Carroll concluded that

"1. Movable kidney is [illegible] entity both clinically and pathologically and demands prompt recognition and appropriate surgical relief.

Such recognition is to be based on the modern methods of examination.

2. Diagnosis requires proof on two points in particular: (a) As to the presence of unduly movable or displaced kidney; (b) as to whether the symptoms complained of are coming from that displacement or mobility.

3. Methods of relief are both palliative and surgical: abdominal binders and nephropexy the latter affording permanent results when properly carried out.

4. Binders are effective only as long as they are worn, no cure or permanent relief being afforded by them.

5. The 'intensive' methods of treatment offer no probability of success and are pure waste of time.

To [illegible]."

DECORTICATION (DECAPSULATION) OF THE KIDNEY

This operation was suggested by Edebohls for the relief of acute or chronic nephritis with hypertension and urinary manifestations. It has also been used in acute suppression of urine, in uremia and in mercurial poisoning. The object is to release the kidney from pressure and to supply [illegible] new anastomotic circulation through the cortex of the kidney. It should be done under local or spinal anesthesia. It consists of stripping and removal of the kidney capsule (Figs. [illegible] a, b, p. [illegible]).

NEPHROSTOMY AND NEPHROTRESIS

Nephrostomy consists of incising the kidney and suturing the lips of the renal wound to the parietes followed by drainage which may be either temporary or permanent.

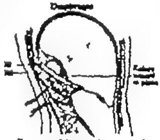


Fig. [illegible]. Schematic drawing to show position of kidney when sutures are drawn tight and tied. (Courtesy of Dr. Vincent O'Conor.)

Nephrotresis denotes the establishment of long continued or permanent drainage of the kidney and is used in cases of irremediable ureteral obstruction or in malignant tumors of the bladder demanding total cystectomy.

Both of the procedures will be described together. They are practically the same as nephrotomy except that drainage (tube) is established and the urine collected in a receptacle (Figs. [illegible]). Patients may be permitted to go about their business with properly constructed apparatus. The skin and clothing of the patient may be kept dry and [illegible] comfortable treatment assured. Lumbar drainage allows compensatory hypertrophy of the opposite kidney. Inflammatory products may become absorbed. Blocked ureter the result of inflammation may become patent again. Later after the function of the opposite kidney is adequate again, nephrectomy of the diseased organ may come under consideration.

NEPHROTOMY

Step 1. Expose and explore the kidney as described above.

Step [illegible]. Deliver the kidney onto the patient's back. Secure temporary hemostasis by having an assistant compress the hilum of the kidney with his fingers or surround the pedicle with [illegible] small rubber tube applied snugly but not too tightly; an artery forceps clamping the two ends of the tube prevents its slipping. An intestinal forceps of the Doyen type, the blades of which are covered with rubber, may be used instead of the preceding methods. The operation is then rendered bloodless. Of course, the ureter cannot be explored when constriction of the pedicle is used as outlined. The delivery of the kidney into the wound is sometimes [illegible] impossible. Under such circumstances an index finger is [illegible] organ and its [illegible]

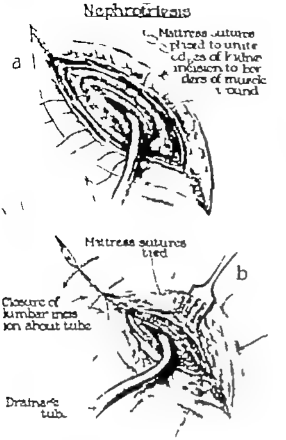


Fig. [illegible]. Nephrotomy and Nephrostomy. a. Kidney opened and explored. Method of placing mattress sutures which unite the edges of the kidney incision to the borders of the muscle wound. b. Closure of lumbar incision about tube.

Step 3. Grasp the kidney between the fingers and the thumb. Make a longitudinal incision along its convex border of a size sufficient to pass the exploring finger into the pelvis of the organ. The incision should be ample for thorough exploration (a portable x-ray unit to fluoroscope the exposed kidney in order to ascertain the presence or absence of calculi is of great aid). Needling of the kidney to ascertain the presence of calculi is uncertain and now rarely used. With a finger in the opening made, the interior of the kidney is explored, aided by counter-palpation on the outside. When no constriction has been used catheterization of the ureter from above will aid in ascertaining the presence or absence of ureteral calculi.

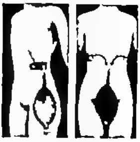


Fig. [illegible]. A. [illegible] Nephrectomy and Lumbar [illegible] Approach for [illegible]. B. [illegible] and Lumbar [illegible] Approach for [illegible].

Step 4. The exploration completed, the wound is closed with interrupted catgut sutures carried on a round (atraumatic) needle. A pad of fat or muscle is sutured over the incision line. The lumbar wound is closed in layers with through-and-through silkworm-gut sutures. Drain when deemed advisable. An advisable method to accomplish this is to place a cigarette drain over the suture line and retain it in place by the ends of the catgut sutures left long for this purpose.

Comment. Calyces are best explored with a blunt-pointed probe of sufficient size so as not to penetrate their walls. An incision extending the whole length of the kidney may be utilized when such exploration is called for. It is safer to drain for a day or two following exploration of the kidney. In abscess of the kidney the site of the incision should be located directly over the abscess. In palpable stone incise directly over the calculus. In nephrotomy for hydronephrosis and pyonephrosis make the incision in as dependent a position as possible to favor evacuation of contents. Arrest of hemorrhage is accomplished by either (a) suture or (b) tamponade.

NEPHROLITHOTOMY

Step 1. The position of the patient is the same as in lumbar nephrectomy. Compress the pedicle of the kidney as outlined above.
Step 2. An incision is made into the kidney as described under nephrotomy.
Step 3. If the calculus is small and lying free in the pelvis of the kidney, pass forceps through the wound in the kidney and extract the stone. (Fig. [illegible].) When the stone is impacted, an incision is made directly over it; when the position of the calculus is uncertain the more extended incision is resorted to. Thorough exploration is essential. The extraction of large stones filling the calyces often becomes a matter of great difficulty. Through

an ample incision, stones are peeled out from the calyces, preferably unbroken. If that is difficult, the calculus should be split up and extracted in sections. All fragments of stone are removed separately by means of forceps, scoop or irrigation. Several incisions made over several stones is preferable to one large mutilating incision.
Step 4. Explore the ureter for calculi.

Fig. [illegible]. Nephrolithotomy. a. Exploration of kidney. b. Removal of stone from pelvis of kidney through small renal incision.

Step 5. Fix a drain in the renal wound.
Step 6. Close the wound in the kidney with catgut around the drain.
Step 7. Close the lumbar wound.

Comment. Hemorrhage may be a serious complication in nephrolithotomy.

PYELOTOMY AND PYELOLITHOTOMY

This consists of delivering the kidney as already described. An incision into the pelvis of the kidney is made (pyelotomy); through this incision stones may be extracted (pyelolithotomy). "Fix" the stone before manipulation to prevent its descent into the ureter. (Fig. [illegible].) Israel admonished that incisions into the pelvis of the kidney should not be made too close to the parenchyma of the organ in doing a pyelotomy for the following reasons:

(a) Sutures are here inserted with difficulty.
(b) The renal parenchyma may be injured during a pyelolithotomy, followed by bleeding and an accumulation of clots in the pelvis of the kidney or ureter giving rise to colic.

The wound in the pelvis of the kidney should be united with interrupted catgut sutures. Incisions heal very rapidly here, in the absence of infection.

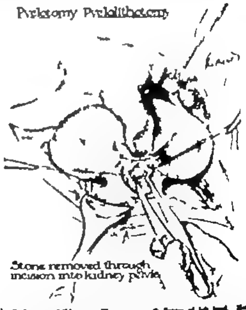


Fig. [illegible]. Pyelotomy-pyelolithotomy. Stone seen with finger of left hand. Method of removing stone after opening pelvis of kidney.

According to the Mayos, closure of the renal pelvis without leakage may be effected even by imperfect sutures if a flap of fatty tissue is made to cover the incision.

Close the lumbar incision. Drain.

Comment. Often grasping a small calculus in the pelvis of the kidney offers difficulties because of the awkward approach from the hilum to the pelvic opening and the angulation from there to any one of the usual three major calyces. The stone should be grasped and withdrawn gently to avoid fragmentation and trauma of the surrounding structures. [illegible] for-

[illegible] single curve, the ability to easily reach into the middle or lower calyx in search of an elusive calculus [illegible].

Randall's forceps (Figs. [illegible]) consist of a set of four forceps, made by [illegible], Philadelphia, progressive in angulation, but of similar construction and weight and are very advantageous in locating, grasping and removing renal calculi through the preferable pyelotomy approach, with [illegible] amount of trauma and time.

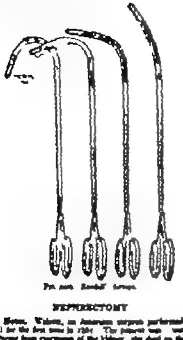


Fig. [illegible]. Randall forceps.

NEPHRECTOMY

Historical Notes. [illegible], an American surgeon performed [illegible] nephrectomy [illegible] for the first time in [illegible]. [illegible]

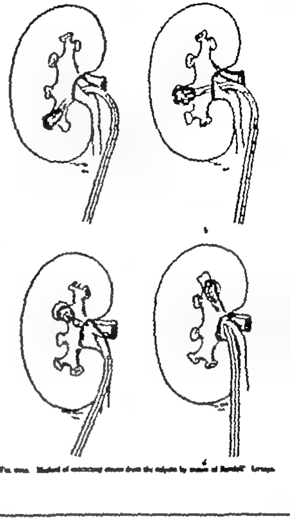


Fig. [illegible]. Method of extracting stones from the calyces by means of Randall forceps.

[illegible]

Lumbar Nephrectomy

The position of the patient, anesthesia, etc., have already been described.

Step 1. Expose the affected kidney by any of the incisions described above. [illegible]

Step 2. The kidney must be separated from its surrounding structures and attachments. [illegible]

[illegible]

Step 3. [illegible] the pedicle. [illegible]

[illegible] Remove the kidney.

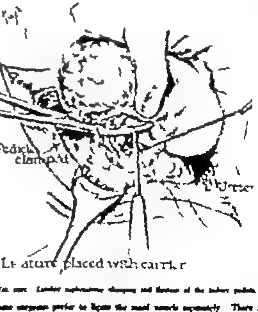


Fig. [illegible]. Lumbar nephrectomy: clamping and ligation of the kidney pedicle.

[illegible]

Step 4. [illegible] Close the wound.

Comment When the ureter is infected, dilated and contains pus, it must be cleaned and either allowed to retract after being ligated and removed (ureterectomy), or left open and fixed in the lumbar wound. If the operation is done for tuberculosis, ureteronephrectomy (Fig. [illegible]) should be done by following the ureter down to the brim of the pelvis or even further down and then removing it. In such instances destruction of the urinary mucous membrane and closing the upper end of the ureter are de-

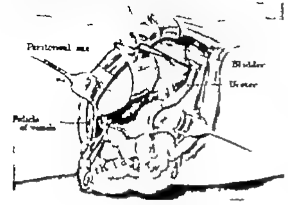


Fig. [illegible] [illegible] ureteronephrectomy

sirable. Mayo has injected carbolic acid into the ureter (about 4 per cent) and found the method effective and harmless.

TUFFIER MORCELLEMENT OPERATION

In secondary nephrectomies this is a safer procedure than classical nephrectomy (Figs. [illegible] p. [illegible]). It consists in removing the kidney piecemeal.

Step 1. Expose the kidney and isolate it as described above.
Step 2. Clear its lower pole.
Step 3. Apply a right-angled clamp transversely to the long axis of the kidney.
Step 4. The portion of the kidney below the clamp is cut away.

Comment When the pedicle cannot be ligated a clamp should be left in situ and removed after two or three days. By that time all danger of hemorrhage is gone. In threatening hemorrhage and in friable structures, clamps may be applied to the pedicle, the kidney removed and the clamp left in situ, surrounded by gauze tampons for two or three days. In hydronephrotic kidneys causing technical difficulties the following method should be resorted to.

Fig. 2027. It is often an error to proceed with classical nephrectomy [illegible] [illegible] [illegible] [illegible] [illegible]. Under such conditions morcellement of the kidney (Tuffier) [illegible] [illegible]. This illustration depicts the procedure. Note clamp on the hilum of the kidney with forceps.

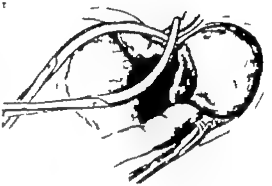


Fig. 2027 (continued). Morcellement of the kidney (Tuffier). [illegible] [illegible] [illegible] [illegible] with finger and scissors. The middle and lower thirds of the kidney have been morcellated. Note position of the clamp and stump of hilum.

[illegible] METHOD

This consists of:

Step 1. Getting down step by step to the capsula propria.
Step 2. Evacuation of the hydronephrotic sac with a trocar.
Step 3. After collapse of the kidney following the evacuation of its liquid contents, deliver the kidney into the wound under visual control, using scissors in the separation of the organ from its surroundings. When the hilum is reached, great care should be exercised in separating adhesions, for in hydronephrosis the vessels are greatly spread out; they should be carefully ligated. When the ureter is to be tied low down, the lumbar incision

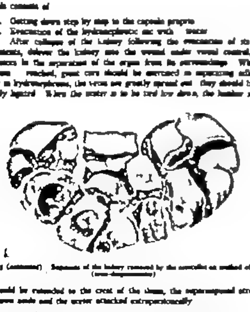


Fig. 2027 (continued). Segments of the kidney removed by the morcellement method of Tuffier ([illegible]).

should be extended to the crest of the ilium, the superimposed structures drawn aside and the ureter attacked extraperitoneally.

Comment In difficult removal of kidneys, Langenbeck's principle, first to secure the blood vessels and then proceed with the ablation of the kidney, is good advice.

The dangers in nephrectomy are numerous, particularly when the operation becomes necessary in cases where a previous nephrotomy has been done, and when the experience of the surgeon is limited. Shock (secondary to the solar plexus) is common. Hemorrhage (primary or secondary) owing to slipping of a ligature or loosening of a clamp must be reckoned with.

Retraction of the Renal Vessels. Ligation under ocular guidance, or, if that cannot be effectively accomplished, tight tamponade is often life saving. Hemorrhage from a torn vena cava or aorta is better avoided than treated. When occurring, suture or tamponade must be resorted to. Injury to the large bowel or duodenum should be repaired at once lest dire [illegible] follow, particularly in injuries to the duodenum, which

usually result from clamping the pedicle and with it a portion of duodenal wall with subsequent necrosis. If discovered, proceed to repair them at once (closing the opening, jejunostomy for feeding). In anuria following nephrectomy first try medical measures, glucose, etc.; if of no avail do nephrotomy on the opposite kidney promptly.

Abdominal (Transperitoneal) Nephrectomy

In large benign or malignant tumors, particularly in the latter, the abdominal approach will give better exposure and tend to more thorough work than is the lumbar operation.

Step 1. Make a Langenbeck incision on the affected side, in the linea semilunaris, along the outer border of the rectus abdominis muscle and extending from the costal margin to within two inches of the pubes. Follow the semilunar line to the peritoneum (p. [illegible]).
Step 2. Displace the colon to the median line. Pack the surrounding structures out of the way.
Step 3. Isolate the mesocolon.
Step 4. Open its outer leaf by a small incision, which is extended by blunt dissection. By avoiding the inner leaf of the mesocolon, injury to the blood vessels will be avoided (Fig. 2027, p. [illegible]).
Step 5. Separate the kidney from its surroundings as far back as the hilum.
Step 6. Ligate the renal vessels with double ligatures in a manner similar to that described under lumbar nephrectomy and divide them (Fig. [illegible], p. [illegible]).
Step 7. Liberate the kidney. When many adhesions are present this step may be one of much difficulty. Deliver the kidney through the abdominal wound.
Step 8. Divide the ureter between artery forceps.
Step 9. Inspect the renal pouch for bleeding.
Step 10. Drain through a stab wound in the loin.
Step 11. Close the abdominal wound in layers.

The drain through the wound is inserted as follows. Thrust a closed clamp backward through the lumbar tissues, just external to the quadratus lumborum muscle, until the skin is raised. Incise the skin over the point of the clamp; this permits the clamp to pass through the opening made. If necessary the opening may be enlarged to permit the passage of an appropriate-sized drainage tube.

When the kidney is bound down by adhesions, the operation may become one of great difficulty. When cysts hamper its delivery they will have to be emptied before satisfactory delivery of the kidney can be effected. Often the treatment of the pedicle offers difficulties.

Dangers Encountered in Nephrectomy

1. Shock
2. Hemorrhage
3. Peritonitis
4. Empyema
5. Embolism (pulmonary and cardiac)
6. Anuria

RESECTION OF THE KIDNEY

Partial Nephrectomy

The greatest usefulness of this operation is in traumatic lesions, tuberculous [illegible] in upper half, [illegible] benign tumors of [illegible] calyx, benign tumors of moderate size and cysts of the kidney.

Czerny was first to perform this operation in 18[illegible]. This case demonstrated that it was possible to obtain satisfactory healing. Tuffier and [illegible]'s experimental studies on dogs have demonstrated that wedge-shaped resections of the kidney heal by first intention.

As much renal tissue as possible should be saved. Even though only [illegible] portion of [illegible] kidney can be saved, this should be done. Compensatory hypertrophy in the remaining kidney tissue takes place as well as in the opposite kidney.

Step [illegible] *Expose the kidney and deliver it.*
Step [illegible] *Gently clamp the vessels.*
Step 3. An assistant steadies the organ while the surgeon removes [illegible] wedge-shaped portion. The incision should extend into healthy kidney tissue.
Step 4. The cut surfaces should be carefully approximated with mattress sutures carrying catgut [illegible] sutures which must include the capsule of the kidney and not be tied too tightly in order to avoid their cutting into the kidney structure. Fat or muscle may be used over the suture line to prevent tearing the parenchyma of the organ.
Step 5. After suturing is completed, the clamp is removed and the wound is closed.
Step 6. Institute drainage. The drain should not extend to the kidney. No packing should be used.

Horseshoe Kidney

Where heminephrectomy is indicated a careful line of cleavage should be found. A wedge-shaped incision permits the wound edges to be brought together with mattress sutures. When this cannot be done, fascia or fat should be sewn against the raw surface. [illegible]'s operation consists of crushing the bridge connecting the two halves of the kidney with [illegible] crushing clamp followed by severing the isthmus of kidney or fibrous tissue between two ligatures.

PERINEPHRITIC ABSCESS

This is best treated by an ample, oblique lumbar incision and evacuation of the pus. Do not wait until pus forms. Early incision, even when no pus is present, often gives prompt relief. Spontaneous opening of a perinephritic abscess is not infrequently followed by fistula; this usually does not occur when the incision is made. *It is important to remember that when operating for perinephritic suppuration the area immediately below the diaphragm should be thoroughly explored. The finger should be passed over the whole surface of the kidney*, down its pelvis and about the upper part of the ureter. The reason for this thorough exploration is that if no pus is encountered where such was suspected purulent accumulations may be found walled off at one of these points, and may be overlooked, if not thoroughly looked for. Rubber drain [illegible]

RENAL FISTULAS

Step [illegible] *Circumscribe with [illegible] sharp pointed scalpel the opening of the fistula on the surface together with [illegible] small margin of skin surrounding it and dissect it out.*
Step 2. Introduce [illegible] probe through the cutaneous orifice along the entire extent of the fistulous tract.
Step 3. Ligate the freed orifice of the fistula snugly around the probe.
Step 4. Dissect out the entire fistulous tract, with the tissues immediately surrounding it, from the contiguous structures, until the kidney is reached.
Step 5. Clear the surface of the kidney around the point where the fistula enters it.
Step 6. Resect a margin of kidney tissue about the entrance of the fistula and excise the fistula with it.
Step 7. Close the opening in the kidney with interrupted catgut sutures.
Step 8. Close the structures about the kidney.

SURGICAL TREATMENT OF INJURIES TO THE KIDNEY

Treatment on Surgical Diagnosis

Where the diagnosis of injury of the kidney has been made by means of laparotomy and it is found that conservative surgical measures would prove inadequate do [illegible] nephrectomy.

Step [illegible] Convert the straight abdominal celiotomy incision into [illegible] Rutherford Morison incision by adding [illegible] horizontal incision to the vertical cut.
Step 2. Pack away the small bowels toward the median line.
Step 3. Incise the outer leaf of the mesocolon on the respective side.
Step 4. Remove blood clots. Secure the pedicle of the kidney and remove the latter as outlined above in discussing transperitoneal nephrectomy (p. [illegible]).

Treatment on Clinical Diagnosis

When diagnosis of injury to the kidney has been made from symptoms and signs and the lumbar approach has been decided upon:

Determine that there is another kidney present (one case of congenital absence of [illegible] kidney is found in every 4,500 individuals) by palpation under anesthesia, intravenous urogram, or transperitoneal exploration with immediate closure of the peritoneum.

Make every possible effort to save the kidney.

Conservative Measures

Tamponade—considered best by Küster.
Partial nephrectomy (Tuffier).
3. Suture of the rent in the kidney.

[illegible] SUTURE [illegible]

Step [illegible] Pass [illegible] deep mattress suture threaded on [illegible] substantial round noncurved needle, the blunt end of which penetrates the kidney substance first. Leave the ends of the sutures long; they are temporarily held in hemostats.
Step [illegible] Introduce deep interrupted sutures of catgut near the margins of the laceration.

Step 3. Include [illegible] segment of muscle from the erector spinae as shown in Fig. [illegible]. Pass it into the rent between the sutures already placed and tie the interrupted sutures over the muscle segment, [illegible] on the anterior surface.

Comment: [illegible] points out that the advantages offered by this procedure are: the sutures do not cut through; the muscle [illegible] fibers [illegible]; the rent is plugged with "[illegible]" [illegible] material.

Nephrectomy is done when (1) the pedicle of the kidney is torn; (2) in multiple lacerations of the kidney substance; (3) when it is impossible to suture the rent in the kidney and (4) in ruptures of the ureter, or when an extensive rent in the kidney cannot be repaired.

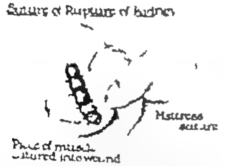


Fig. [illegible]. Method of suture of rupture of the kidney.

THE PELVIS OF THE KIDNEY AND THE URETER

SURGICAL EXPOSURE OF THE URETERS

The ureters may be exposed either through [illegible] extra- or transperitoneal approach. The former is the procedure of choice; the latter is used mostly in operations on the pelvic portion of the ureter.

Retro- (Extra-) Peritoneal Route

This method permits the exploration of the ureter throughout its entire length.

[illegible] EXTRAPERITONEAL ROUTE

Exploration of the Lumbar Portion of the Ureter. Place the patient on his healthy side. Beginning at the outer border of the lumbospinal mass of muscles, [illegible] below the twelfth rib, an incision is made and carried obliquely downward and forward to a point one inch internal to the anterior superior spine of the ilium. Continue this incision parallel to and one inch above Poupart['s] ligament as far as its center (Fig. [illegible], p. [illegible]). Divide the tissues down to but not into the peritoneum. Expose the kidney and its pelvis. Slight traction [illegible]

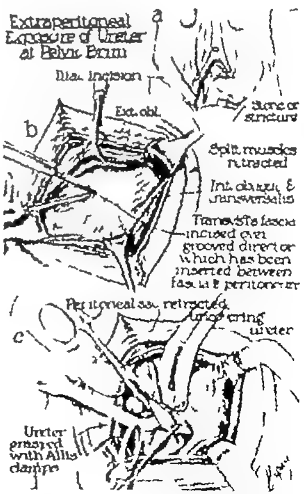


Fig. [illegible]. Extraperitoneal exposure of ureter at pelvic brim. [illegible] approach. b. Division of muscles and transversalis fascia. [illegible] peritoneum retracted, ureter isolated.

on the latter will bring the upper portion of the ureter forward. By gauze dissection strip the peritoneum from the parietes until the ureter comes to view. It must be kept in mind that the peritoneum adheres to the ureter; it must be separated.

Exploration of the Pelvic Portion of the Ureter. If the pelvic portion of the ureter is to be explored, the patient is placed on his back. The wound is enlarged forward if necessary "even as far as the external abdominal ring" (Morris). Care is to be exercised at all times not to enter the peritoneum. If inadvertently opened, it should be repaired at once. An iliac, transrectus or pararectus straight incision (Fig.) without opening the peritoneum will accomplish the same end. I do not like the "muscle-splitting" incision under these circumstances. If the kidney cannot be used as a guide to the ureter this should be looked for at the pelvic brim. The guide here is the place where the ureter crosses the common iliac artery. The ureter should be stripped off the peritoneum; in the male, it may be traced, in this manner to the bladder. In the female, the procedure is rendered difficult because the ureter courses in the broad ligament, the uterine artery lying in front and the uterine veins posterior to that structure. Median abdominal incisions may also be used for extraperitoneal exposure of the lower fourth of the ureter. The incision commences just below the umbilicus in the median line and extends to the pubes. The peritoneum is not opened; the bladder is recognized, pulled up into the wound and the ureters sought as they enter the bladder. A Pfannenstiel incision or its modification may accomplish the same end.

Transperitoneal Route

The ureter may be exposed through a median or a lateral transperitoneal incision. It is under many conditions the preferred incision because it permits the exploration of the opposite kidney, etc.

PLASTIC OPERATIONS ON THE KIDNEY PELVIS

If, after finishing a pyelotomy or pyelolithotomy operation (p.) it is found that the opening in the pelvis of the kidney cannot effectively be closed by the usual method, Fenger's operation is of value.

Fenger's Operation

This consists of dissecting and turning back a small flap of fibrous capsule from the posterior surface of the kidney, followed by its approximation over the line of the suture in the pelvis of the kidney by catgut sutures (Fig.).

PYELOSTOMY

As in nephrostomy used for draining the kidney, the object may be accomplished by draining through the pelvis of the kidney. It is indicated when more radical procedures are out of the question for the time being (pyonephrosis, hydronephrosis, etc.). The operation consists of exposing the pelvis of the kidney and splitting it. A drainage tube is introduced and the pelvis of the kidney sewn around it as in cholecystostomy. Drain the lower calyx.

Operative procedures are indicated in small hydronephrotic sacs under certain conditions, such as intermittent hydronephrosis or in stricture or occlusion of the first part of the ureter.

The following operations sometimes come under consideration.

Nephropexy

The technic for this procedure has already been described (see p.), the object being to avoid kinking of the ureter thus avoiding reaccumulation of urine.

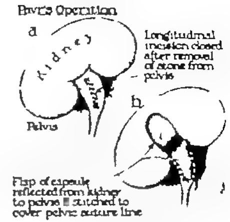


Fig. . Fenger's operation for plastic repair of pelvis of the kidney. Above (a) repair of pelvis under favorable conditions.

Nephrectomy and Pyelectomy

These also are occasionally considered. They are used either as independent procedures or in conjunction with plastic operations to secure the uninterrupted kinking of the latter.

TRENDELENBURG'S OPERATION

This is used when there is a spur at the junction of the ureter with the pelvis of the kidney causing difficulties. Trendelenburg first performed this operation in . It consists of incising of the hydronephrotic sac and exposing the spur through the transpelvic incision. The ureter is incised thus obtaining a V-shaped defect, the apex of which forms the new opening into the ureter after suturing the mucosa of the ureter and pelvis of the kidney with catgut sutures.

STRICTURE OF THE URETER

Christian Fenger's Operation

This operation is useful in strictures of the upper portion of the ureter. It was later used with success by Mayo, Israel, Bardenheuer and others. The

operation is based on the Heineke-Mikulicz principle of pyloroplasty, e.g. a longitudinal incision is made through the strictured area embracing the affected portion of the pelvis of the kidney and ureter and the defect is sutured transversely.

PYELO-URETEROTOMIES

Morris' Operation

This operation is useful in cases of hydronephrosis in which distention of the renal pelvis has caused a displacement of the ureteral orifice or a valve-like condition at this point, causing an impediment to the outflow of urine from the pelvis of the kidney.

Step 1. Expose the kidney and the upper part of the ureter in a manner already described.

Step 2. Clear and expose the pelvis and first part of the ureter. Deliver these into the wound.

Step 3. If the pelvis of the kidney is distended with urine, evacuate it with a trocar entering the pelvis through its posterior surface near its ureteral junction. An incision about half an inch in length is made in the renal pelvis in the direction of the outlet of the pelvis.

Step 4. Introduce a pair of scissors so that one blade of the latter is in the ureter, the other in the pelvis of the kidney. The incision is made in such a manner that the cut in the ureter will approximately correspond to the lowest point of the hydronephrotic sac.

Step 5. The posterior wall of the ureter and that of the hydronephrotic sac are now united by a continuous catgut suture and continued along the anterior wall.

Israel's Operation

This consists in plicating the hydronephrotic sac. A diminution of the sac and straightening of the course of the ureter is aimed at.

Albarran's Operation (Resection Orthopedique Pyelorenale)

This operation consists in resecting the hydronephrotic sac with retention of normal conditions at the ureteropelvic opening and a plastic reconstruction of the renal pelvis.

URETEROPYELONEOSTOMY

Küster's Operation ()

This procedure is mainly useful in severe impermeable stricture of the upper ureter.

Step 1. The operation consists of first doing a nephrotomy.

Step 2. Divide the ureter immediately below the stricture.

Step 3. Separate it sufficiently from its surroundings so that it can be brought up to the sac without tension.

Step 4. Split the upper end of the ureter.

Step 5. Make an incision through the posterior wall of the hydronephrotic sac, at its lowest level.

Step 6. Spread the split ureter open and suture it to the divided internal surface of the anterior wall of the sac. The ureter is thus formed with a funnel-shaped opening into the sac.

URETEROTOMY AND URETEROLITHOTOMY

Ureterotomy indicates incision into the ureter. It is usually done for the removal of a calculus in which event we speak of ureterolithotomy. Either the extra- or the transperitoneal approach may be used in accomplishing this end. In stricture dilatation should be attempted before resorting to surgery.

Ureterotomy for Stricture of the Ureter

Step 1. Locate the stricture by ureteral catheterization; the catheter is permitted to remain in situ (Fig. , p.).

Step 2. Expose the stricture.

Step 3. Make a longitudinal incision into the strictured ureter dividing all its coats.

Step 4. Push the catheter past the strictured point.

Step 5. Place sutures in such a manner as to convert the longitudinal incision into a transverse wound. Leave the catheter in the ureter for a few days. Use additional drains if deemed advisable.

Ureterotomy for Other Conditions

Step 1. Expose the ureter by one of the extraperitoneal methods described. (Figs.) For efficient work, exposure must be thorough and adequate. During the exposure of the ureter care must be taken not to injure the peritoneum, the blood vessels or the spermatic cord.

Step 2. Deliver the ureter into the wound as in delivery of the spermatic cord in herniorrhaphy.

Step 3. The incision in the ureter should always be longitudinal and made while it rests on the index finger.

Step 4. Explore the length of the ureter upward and downward with probes, bougies and sounds (Fig.); these will detect the presence of calculi, strictures, diverticulae, etc. Wax-tip bougies may be used to advantage.

Step 5. Close the ureterotomy wound with fine chromic catgut carried on a small, curved intestinal needle which is made to penetrate all the coats of the ureter except the mucosa.

A B

Fig. . A, Ureteral catheter. B, Ureteral bougie.

Comment. The marked tendency of wounds in the ureter to heal is well known; nevertheless it is wise to close the opening as outlined. In strictures of the ureter that have been divided, or if development of a stricture is feared it is well to close the wound in the ureter transversely (Heineke method) and thus obtain an enlarged lumen. Dilatations of strictures are attempted via the cystoscopic route using special catheters and bougies or by dividing the stricture as is practiced in internal urethrotomy. When the stricture is located above

the bladder an extraperitoneal approach may be resorted to. When caused by adhesions these may be released and cure effected.

Surgical Management of Calculi in the Lower Ureter

Accurate exposure of calculi in the pelvic portion of the ureter demands precise knowledge of the regional anatomy.

Anatomic Considerations. The pelvic portion of the ureter is about fifteen centimeters in length and consists of two divisions, parietal and an intravesical. The former is in close relation to the peritoneum. The ureter crosses the brim of the pelvis, lies lateral to the bifurcation of the common iliac artery, and descends between the peritoneum and the internal iliac artery. In the male just before it enters the bladder it is crossed internally on its anterior aspect by the vas deferens. The superior vesical artery will also be noted in close relation to the ureter just above this point. In the female, the ureter passes to the posterior peritoneal layer of the broad ligament and enters the parametrium, through which it passes toward the cervix. At the side of the cervix, the ureter is covered by the veins of the uterovaginal plexus. It is crossed anteriorly by the uterine artery, and then inclines anteriorly, medially and downward to reach the wall of the bladder.

In its intravesical course, the ureter traverses the bladder wall obliquely from without inward for about three-fourths of an inch, to end in the ureteral orifice.

Blood Supply. The blood supply of the pelvic portion of the ureter is obtained in the male from branches of the superior vesical and internal iliac arteries, and in the female from the uterine and inferior vesical arteries. The arteries and veins form a network enclosing the ureter.

Nerve Supply. The ureter receives its innervation chiefly from the inferior hypogastric and vesical plexuses and the upper sacral ganglia. Fibers from all these sources anastomose freely.

Peritoneal Relationships. At this level in the pelvic area, the ureter will be found definitely adherent to the peritoneum.

Anesthesia. Spinal anesthesia, regional field block, or ethylene-gas inhalation may be used, spinal anesthesia being preferred because of the relaxation afforded.

Preliminary cystoscopy is performed and a ureteral catheter or bougie is inserted up the ureter on the affected side. This acts as a helpful guide in subsequent exposure of the ureter.

Position of the Patient. The patient is placed in moderate Trendelenburg position after the cystoscopy is completed.

ILIAC INCISION (MUSCLE-SPLITTING INCISION)

Step 1. This approach is utilized in attacking calculi located slightly above the brim of the pelvis, and is the one preferred by Lower. The incision should be carried out as a muscle-splitting procedure (Fig. [illegible]). The skin is incised parallel to Poupart's ligament, beginning just above and medial to the anterior superior iliac spine and terminating at the lateral border of the rectus muscle. The external oblique aponeurosis is divided in the direction of its fibers, and the internal oblique and transversus muscles are similarly separated. The transversalis fascia is then incised over a grooved director inserted between it and the peritoneum. The wound is widely exposed by means of self-retaining retractors.

Step 2. The peritoneum is freed carefully from the lateral wall of the abdomen and the iliac fossa, by pushing it gently toward the midline. The ureter

must not be sought on the floor of the pelvis. It is always adherent to the posterior peritoneum, and can invariably be located by palpation just above the bifurcation of the iliac vessels.

Step 3. Exposure of the ureter can be facilitated by the introduction of the Conrad lighted retractors into the depths of the wound.

Step 4. The ureter is liberated from the peritoneum for the shortest distance compatible with good exposure, in order to conserve its blood supply. The calculus is located by palpation, and immobilized by the application of Allis clamps to the ureter above and below the stone (Fig. [illegible] b).

Step 5. The ureter is incised longitudinally, preferably slightly above the site of the calculus rather than exactly over it. The stone can then be extracted by means of specially designed ureteral forceps, scoops, or Lower's rongeur, flexible curet (Fig. [illegible] c, d).

Step 6. Following removal of the stone, the ureter should be explored by bougies to determine its patency down to its termination in the bladder. Whenever feasible, the ureteral incision should be sutured with very fine chromic catgut. Suture should be carried out over a ureteral catheter to avoid inclusion of the posterior wall of the ureter in the stitch (Fig. [illegible]).

Step 7. Drainage should always be instituted, preferably with soft rubber tubes, such as Penrose tubing placed parallel to the iliac vessels to avoid pressure on these important structures. The abdominal wall is closed in layers, interrupted sutures being used throughout, and the drain brought out at the lower angle of the wound.

PARARECTUS INCISION

This is the approach advocated by Rose. The skin incision is placed just medial to the iliac semilunaris, and ordinarily made about ten centimeters in length. It is carried through the lateral aspect of the rectus sheath, the rectus muscle being retracted medially. Like the iliac incision, this is also an extraperitoneal approach, the peritoneum being pushed medially to expose the ureter.

This route is indicated for stones below the brim of the pelvis and in the juxtavesical portion of the ureter. The deep epigastric vessels are exposed by this incision, and must either be ligated or pushed aside. Caution must be exercised in the male to avoid injury to the vas deferens as it crosses the ureter. In the female, the uterine artery must be pushed off the ureter or doubly ligated and divided to avoid troublesome hemorrhage.

Once the ureter is exposed, the subsequent steps of the operation are similar to those outlined under the discussion of the iliac approach.

MEDIAN SUPRA-PUBIC INCISION

Judd's Approach. This is suitable for stones in the ureter just above the bladder, or for calculi situated in the intramural portion of the ureter. The incision is comparatively bloodless. It enables the operator to open the ureter close to its junction with the bladder and permits exposure of both ureters through one wound. Its chief disadvantage is that detection of the ureter is somewhat more difficult than through the other approaches.

Step [illegible]. The skin incision begins just below the umbilicus in the midline and is carried to a point just above the symphysis pubis. The rectus muscles

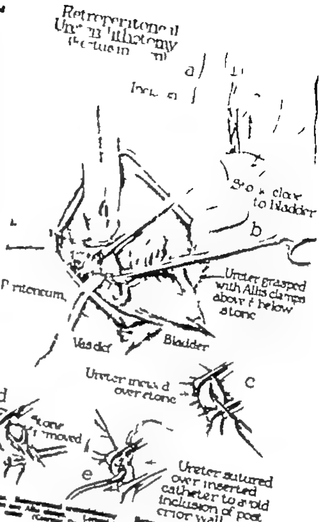


Fig. [illegible]. Retroperitoneal ureterolithotomy. a, Incision. b, Ureter grasped with Allis clamps. c, Ureter incised. d, Stone removed. e, Suture of ureter over catheter. (Courtesy Dr. A. C. Fleischmann.)

are separated along the linea alba, and the prevesical pad of fat and the peritoneum are carefully stripped away from the lateral walls of the pelvis and the bladder on the side where the stone is situated.

Step 2. The bladder is grasped by small Allis forceps and pulled to the side opposite the location of the calculus. The ureter is carefully liberated for a short distance, and the calculus immobilized and removed by the method previously described.

Step 3. Stones situated in the intramural portion of the ureter necessitate cystotomy. The bladder is incised, and self-retaining retractors are inserted together with illuminated retractors to expose the upper and lower limits of the bladder wound. Incision over the stone is made with the electrosurgical scalpel, and the stone is removed (Fig. [illegible]). The margins of the incision are then gently coagulated with the pointed bulbous electrode to control hemorrhage, which frequently occurs from the small vascular artery in this area as recommended by A. C. Fleischmann.

COMPLICATIONS

Injury to the Peritoneum. If the peritoneum is inadvertently torn, the rent should be accurately closed with continuous suture of fine catgut.

Hemorrhage. Most hemorrhages can be controlled by digital compression and by careful ligation of the uterine artery and of the deep epigastric artery when these vessels cannot be safely pushed out of the operative field. If hemorrhage occurs, its control can be greatly facilitated by employment of illuminated retractors to expose the bleeding site.

Infection. In the prophylaxis of infection, three factors are of importance: limited mobilization of the ureter in order to conserve its blood supply, suturing of the ureteral incision, wherever feasible, and institution of drainage according to the principles outlined above. If infection does occur the incision must be kept open and drainage instituted for a prolonged period. Insertion of an indwelling ureteral catheter by diverting the urinary flow in many cases hastens control of the infection.

Ureteral Fistulas. These are usually due to stricture of the ureter or accidental inclusion of the posterior wall during closure of the ureteral incision. Fistulas of brief duration can usually be treated successfully by insertion of a ureteral catheter from below which is kept in place four to ten days. Occasionally the ureter must be resected proximal to the stricture and reimplanted into the base of the bladder. If the above procedures fail, temporary nephrostomy or nephrectomy may be necessary.

POSTOPERATIVE CARE

Prompt stimulation of renal function is essential. Administration of fluids orally and parenterally is carried out routinely, especially with 5 per cent glucose in physiological saline solution intravenously. The latter is of great value in the presence of suppressing anuria.

Control of pain is achieved by small doses of [illegible], being preferable to morphine because of [illegible].

Postoperative abdominal [illegible] lated by insertion of a small [illegible]

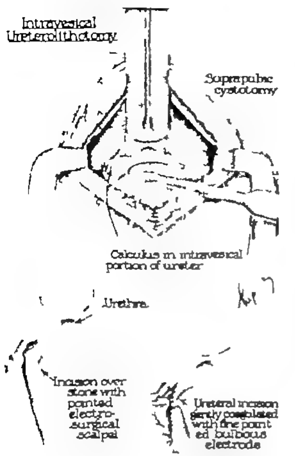


FIG. [illegible]. Intravesical ureterolithotomy by the [illegible] approach. (Above) [illegible] of intravesical calculus. (Right) Ureter opened with electrosurgical scalpel. (Left) Margins of ureteral incision gently coagulated. (Courtesy, Dr. A. C. Fleming.)

hypodermically at eight-hour intervals, and application of hot abdominal stupes, frequently changed.

The skin sutures are removed on the eighth and the tension sutures on the fourteenth day in the usual case. The patient is allowed out of bed on the eighth to the tenth day.

Comment. That not all renal calculi demand surgical removal is pointed out by Bransford Lewis.

URETERAL ANASTOMOSIS

(See Chapter on Gynecology, [illegible].)

URETEROSTOMY OR DERMATO URETEROSTOMIA

In cases of malignancies of the urinary bladder, in contraction of the bladder, in tuberculosis of certain parts of the urinary apparatus, in impending death from uremia and in loss of substance of the ureter, transplantation of the ureter onto the loin becomes necessary. An appropriate vessel collects the urine on the loin. Le Dentu was first to employ this method. The operation consists of exposing the ureter extraperitoneally where the ureter crosses the iliac vessels, ligating it doubly and dividing it. The lower ligature is cut short, the upper is left long. An appropriate opening into the peritoneum through which the ureter is delivered, is made. The end of the ureter now lying on the surface of the skin is split open longitudinally for about half an inch and the flaps are folded over the skin to which they are sutured.

ENTERO-URETERAL ANASTOMOSIS

The following methods are at the disposal of the surgeon, depending upon the degree of injury to the ureter: ( ) nephrectomy; (b) dermato-ureterostomy; ( ) transverse-ureteral anastomosis; (d) uretero-ureteral anastomosis (see p. 1818); ( ) ureterovesical anastomosis.

Comment. P. Brooke Bland[1] emphasized the important points for identification of the ureter which are:

1. (Kelly's Test). The vermicular or peristaltic wave, excited by gently stroking the tube. This, when observed, is regarded as pathognomonic.

The absence of bleeding when the ureter is incised. This, of course, one would not deliberately do to identify the duct, but is decisive when done accidentally.

3. The consistency and thickness of the ureter. It is thicker and harder than a vein, flatter but softer than an artery.

4. The absence of pulsation.

5. The yellowish-white hue of the ureter.

6. The changing contour of the tube, flat and ribbon-like while at rest, tubular or cylindrical when in action.

7. The relation of the tube to certain anatomical landmarks.

8. At the pelvic brim it dips into the pelvis in traversing, from without inward, the iliac vessels.

9. The abrupt upward curve assumed as the ureter approaches the side of the cervix.

[1] Jour. A.M.A., Oct. [illegible]
Atlantic Medical Journal, [illegible].

10. The inward curve assumed as it approaches the bladder wall.

The horizontal course of the uterine vessels in front of the ureter as they approach the side of the cervix.

12. The constant tendency of the tube to adhere to the mesial, inner or posterior leaflet of the peritoneum. (This tendency is never displayed by blood vessels.)

13. Identification, as already mentioned, by inserting indwelling catheters immediately before starting operation.

14. Finally, differentiation between the ureter and the remnant of the hypogastric artery must be kept in mind. The artery followed backward, leads into the anterior division of the internal iliac artery. The ureter, on the other hand, travels over the pelvic brim and the iliac vessels into the renal fossa.

Correct identification and isolation of the ureter should eliminate injury or occlusion of the ureter.

In a later publication P. Brooke Bland[1] states that:

While hysterectomy, either abdominal or vaginal—but more commonly the former—is largely responsible for ureteral injury, there are a great many other surgical procedures on which responsibility may be placed. A tabulation of operations—twenty-four in all—in which the accident has occurred, is given below. In order of frequency they may be summarized as follows:

1. Radical abdominal hysterectomy (Wertheim's method for cervical carcinoma).

2. Radical vaginal hysterectomy (Schauta method for cervical carcinoma).

3. Combined vaginal and abdominal hysterectomy for cervical carcinoma.

4. Vaginal hysterectomy (clamp method for uterine conditions other than carcinoma).

5. Total abdominal hysterectomy for uterine myomata, especially if adherent and associated with intraligamentous growths.

6. Operations for the removal of intraligamentary cysts.

7. Subtotal hysterectomy (supravaginal) for myomata, especially if adherent or complicated by intraligamentary neoplasms.

8. Hysterosalpingo-oöphorectomy for extensive pelvic inflammatory disease.

9. Herniotomy, especially if complicated by congenital or acquired malposition of the bladder and ureter (Cochez in 1904, reported eleven such cases, six inguinal and five femoral) (Harman).

10. Operations for the removal of vesical neoplasms.

11. Surgical correction of vesicovaginal fistulas.

12. Operations upon or in the region of the kidney itself.

13. Porro operation.

14. Operations upon or about the appendix and cecum.

15. Operations upon or about the sigmoid and rectum.

16. Operations for removal of retroperitoneal pelvic tumors.

[1] Med. J. and Rec. Oct., [illegible]

17. Extensive plastic operations upon the anterior vaginal wall, especially for uterine prolapse.

18. Perforation of the ureteral wall in passing the ureteral catheter (Noble).

19. Operations upon a horseshoe kidney or where double ureters exist.

20. Trauma of the ureteral wall from undue manipulation or from damaging the blood supply followed by necrosis in various pelvic operations.

21. Kraske's operation for rectal carcinoma.

22. Percy's method of treating uterine carcinoma.

23. Ureteral injury sustained from the application of radium. (Baldwin's case.)

24. Instrumental labor. (P. Brooke Bland.)

Transplantation of the Ureters Into the Large Intestine

Historical Notes. Cyril A. R. Nitch surveyed this important field of surgical endeavor admirably. The earliest attempts to divert the flow of urine from its natural receptacle were made in the endeavor to relieve the distressing symptoms associated with extroversion of the bladder. The first recorded operation for this purpose was performed in 1851 by Sir John Simon of St. Thomas' Hospital. He established a fistula between the ureter and the rectum by means of tight ligatures passed through their adjacent walls with an ingenious instrument he devised for the purpose. Subsequently, he ligated the lower end of each ureter. The operation was not entirely successful, for though some urine passed by the bowel, the ureteric orifices were not completely obliterated. The patient, a boy, died a year later and at the postmortem "the ureters were blocked with calculi and both kidneys were seriously diseased." It is interesting to note that Coffey's latest technic (and the one which has been most successful in dogs than any other) is similar in principle to the operation devised by Simon over eighty years ago.

The next attempt was made twenty-seven years later by Sir Thomas Smith of St. Bartholomew's Hospital in 1878. He actually transplanted each ureter into the back of the ascending and descending colon, so to him belongs the credit for the first operation of this nature. Although [illegible] failed, [illegible] deserves full recognition as the work of a pioneer and a brilliant surgeon. He operated on the left side first, but the ureter came away from the bowel and, unknown to him, its lumen was obliterated by scar tissue and the kidney atrophied. The patient recovered and, being in good health, fourteen months later the transplant was done on the right side, but unfortunately, the ureter was so compressed by the sutures that death from suppression of urine took place on the third day.

After an interval of thirteen years in which not a single case was recorded, though some may have been attempted, surgeons suddenly awoke to the possibilities of the operation for between 1891 and 1897 a number of cases were reported in which the operation was performed for growths, tuberculosis and fistula of the bladder as well as for extroversion. The dangers of leakage, stenosis and renal infection were fully realized and many methods of overcoming them were devised. Trendelenburg (1891) preserved a button of vesical mucosa, Boari used a metal button, Tuffier (1892) used ureteral catheters, and Rein (1894) and Chalot (1896) tied tubes of glass and of nickel into the ends of the ureters, but those cases which did not die of shock or peritonitis succumbed sooner or later to pyelonephritis.

In this period the transplantation was effected by the direct method with little or no attempt at valve formation until 1896, when Krynski and later Martin, 1899, placed the ureters between the walls of the bowel in imitation of their vesical course, while Fowler in 1898, made a valve with a flap of rectal mucous membrane.

Though many surgeons reported cases operated on by one or other of these

[1] Proceedings of the Royal Society of Medicine, July [illegible]

methods, the immediate mortality was still very high and most of the survivors died of renal infection within two and a half years.

The only operation with almost negligible mortality and prolonged survival was the extraperitoneal rectal transplantation of the ureters by Peters. In July of the same year two patients were alive and well seven and four years later and several cases operated on by other surgeons were successful. But of course this operation could be employed in prolapsed bladder only.

In 1907 Sir Harold Stiles introduced his [illegible] method which was attended with remarkable success; for five of his cases (traced by G. Grey Turner) were alive and well six, nine, fifteen, sixteen and twenty years after operation.

Subsequently G. Grey Turner (in 1920) reported seventeen cases operated on by the same method between 1911 and 1927 with four deaths, the survivors being quite well from one and a half to fifteen years after operation. These figures given by two surgeons whose reports can be relied on, make Koch wonder if the more complicated oblique transplantation is necessary, but on the whole he thinks that it is worth persevering with, for the ureter is less liable to be compressed and the valvular action diminishes the danger of ascending infection. Moreover one must remember that most of Stiles and G. Grey Turner's operations were performed in two stages and all were for other conditions [illegible], so that in most of these cases the ureters and kidneys would be more or less healthy.

Finally, in 1925 Coffey performed his first of [illegible] bilateral transplantation with tubes, [illegible] and since then has so improved his technique that in his latest publication he was able to record thirty five cases, both simple and malignant, with a mortality from all causes of [illegible] per cent and [illegible] mortality directly attributable to the operation of only [illegible] per cent.

Koch stresses that the mortality was [illegible] per cent for unilateral and [illegible] per cent for bilateral transplants (Stiles) and most of the survivors developed some form of renal infection.

Peterson has not been able to trace [illegible] single case in which the kidneys were found to be normal beyond dispute [illegible] on all autopsies survivors showed [illegible] evidence of either stricture of the ureteral orifice, hydroureter, hydronephrosis or pyelonephritis.

The chief causes of the high operative mortality in these are the technical difficulties of the operation, the small ureter and the rigid thick-walled rectum peculiar to the [illegible], while in the successful cases the renal infections can be ascribed to the mode of implantation, for in the majority the ureters were transplanted by the direct as opposed to the "oblique" method.

Coffey in [illegible] made [illegible] notable advance with his oblique submucous method. Signs of renal infection ensued. However further experimental work on similar lines by Coffey and others has been disappointing.

In 1930, Walker-Taylor conceived the idea of tunnelling instead of dividing the wall of the bowel and by means of his [illegible] he [illegible] succeeded in diminishing [illegible] and reducing postoperative renal infection.

Amongst operations by Coffey's latest technique, oblique transplantation with delayed fistula formation by transfixion suture, in his words "there is comparably better results than have been obtained by any other method." More than [illegible] operated by him up to [illegible] after operation all showed normal kidneys. If this operation yields as good results in [illegible] large series of patients and after [illegible] periods and if it is not followed by stricture of the ureteral orifice it will undoubtedly be the operation of choice in possible cases in man.

Two operations have now been standardized, each giving satisfactory results. They are the semi-oblique method of Stiles, with the catgut suture guide of Charles Mayo, and the oblique submucous method of Coffey with tubes or catheters. Coffey's method enables as closely as possible both the natural course of the ureter and the valvular action which prevents the bacterial flora present in the intestine being transmitted to the kidney, in which the pressure is low and regular. But in

The operation consists of uniting the proximal end of the ureters to the large intestine, preferably the sigmoid flexure or rectum, although the caecum and colon may be utilized. The transperitoneal route is chosen. The principles of the operation are to allow the ureters to open obliquely upon the mucous membrane of the bowel in [illegible] valvular manner to simulate as far as possible the design of nature. Much commendable work in this phase of surgical research has been done by Chaput, Bovée, Krynski, Martin, Van Hook, Coffey, C. H. Mayo, Hendricks, and others.

Step 1. Insert sigmoidoscope, clamp the pelvic colon and irrigate the bowel thoroughly first with water and finally with mercurochrome.

Step 2. Pass transfixion needle through the wall of the bowel just below the clamp.

Step 3. Pack the rectum with gauze and withdraw the sigmoidoscope.

Step 4. Divide the ureters close to the back of the bladder and free them as [illegible], usually to about the common iliac artery on each side.

Step 5. Either No. [illegible] rubber tubing or No. [illegible] whistle tip catheters are then passed up the ureters for about [illegible] cm. and held in position by fine catgut ligatures. Divide the muscular coat of the lower part of the sigmoid, region of the site of election, diagonally for one and a half inches from the edge of the mesentery toward the midline on each side at different levels, being lower on the left and separate freely from the mucosa to make good bed for the ureter.

Step 6. Puncture the mucous membrane at the lowest part of each incision.

Step 7. Pull out small knuckle of the gauze packing and the corresponding catheter or tube attached to it.

Step 8. Withdraw the gauze from the anus which pulls with it the attached catheters until the ends of the ureters lie just within the bowel.

Step 9. Bury the ureters by one or two layers of Lembert sutures, some of which catch up their wall.

Step 10. Suture the pelvic peritoneum in such a way as to cover the ureters completely and fix the intestine.

KOCH'S MODIFICATION OF COFFEY'S OPERATION

Preparation. Koch does not irrigate the bowel but the abdomen is opened his colon is [illegible] good purge, an enema overnight, another on the morning of the operation and [illegible] through wash-out two hours before the patient comes to the operating room. Coffey may consider irrigation one of the secrets of his success, but Koch doubts if [illegible] is easily at any practical value. If it is required can be done more rapidly and more effectively with a long rectal tube passed up the sigmoidoscope.

The site of the transplant (i.e. the "site of election") cannot be predetermined [illegible] but should be controlled by the blood supply of the ureter. The arteries which supply the pelvic portion of the ureter arise from the superior vesical and the middle haemorrhoidal and are very variable in size, length and position, even differing on the two sides in the same individual. The spermatic artery does not seem to give off any ureteric branches below the brim of the pelvis. Mr A. L. P. Jeffery, Demonstrator of Anatomy at St. Thomas' Hospi-

spite of this, one cannot overlook the fact that the results of the Stiles operation, in which there is no attempt to make a perfect valve, are remarkably good.

The third method of oblique transplantation with delayed fistula formation (Figs. 803, 804) devised by Coffey is now on trial and promises to give even better results.

STILES' OPERATION

Step 1. Divide the ureter as low as possible. Preserve its blood supply.

Step 2. Cut the end of the ureter obliquely.

Step 3. Tie a catgut suture through its point and tie it; the short end of the suture is threaded up the ureter (Mayo's ureter guide) and the other is armed with a needle.

Step 4. Make a small transverse incision in one of the longitudinal bands in the lower end of the pelvic colon and puncture the mucosa. The needle carrying the suture on the ureter is passed into the lumen of the bowel through this opening and brought out half an inch lower down.

Fig. 803. Coffey [illegible] anastomosis [illegible] technique of ureteral transplantation [illegible]

Fig. 804. [illegible] A [illegible] B [illegible] (After Coffey, Brit. Jour. Urol. [illegible])

Step 5. Draw the ureter into the bowel and keep it in position by tying the suture.

Step 6. Bury it finally in the wall of the intestine for a distance of one and a half inches by two rows of Lembert's sutures in the manner of a Witzel gastrostomy.

The opposite ureter is transplanted at a higher level two or three weeks later.

COFFEY'S OPERATION (WITH TUBES OR CATHETERS)

This procedure is indicated when vesical anastomosis is for some reason or other impossible as in:

Cystectomy

Ectopia vesicae

3. T[illegible] [illegible] ureteral fistula

When the ureter is divided so high that it cannot be pulled down to the bladder without undue tension.

tal, ascertained that for Koch by injecting several specimens and internal iliac arteries showing the variation on opposite sides of the same body.

"When the ureteric arteries arise near the brim of the pelvis they can be preserved without difficulty and the transplant can be made into the termination of the pelvic colon, but when they join the ureter near the base of the bladder it may only be possible to save them by [illegible] very low and difficult transplant or, as usually happens, they have to be divided. The viability of the implanted portion of the ureter will then be seriously jeopardized and will depend solely upon the amount of the anastomosis with the spermatic branches. This applies particularly to the right ureter for being further from the brim than the left, has to be strung further upward to make contact, and consequently vessels reaching low down are always divided. The blood supply of the left ureter is generally safe for besides being closer to the bowel it is also closer to the middle haemorrhoidal artery."

Koch is convinced that sloughing of the implanted portion of the ureter not infrequent cause of postoperative death, is due more often to its insecurity than to infection, for [illegible] occurred on the right or difficult side in three of his four fatal cases which were due to that cause. In two of these the vessels were so short that they had to be divided, and in the third, when preparing the field for transplantation of the left ureter, fortnight after transplantation of the right, the blood supply of the latter was damaged while separating some firm adhesions over the anastomosis. Death took place twenty-four hours later and at the postmortem the recent left junction was sound but the intramural one and one half inches of the right ureter had sloughed completely. Koch therefore came to the conclusion that if the blood supply of the lower end of the right ureter cannot be preserved, about an inch of it should be sacrificed, the pelvic colon pulled well over to the right, and the junction made at a higher level than usual. Koch further states:

"Mr. Jeffery has suggested that ureteric necrosis may also be caused by spasm of the muscular wall of the ureter and has pointed out that in benign prostatic there is no spasm, but in the true ulcerative form where the muscular wall is invaded, the spasm is so pronounced as to be diagnostic in sigmoidoscopic examinations. He makes the helpful suggestion that the injection into the wall of the bowel of a local anaesthetic having a prolonged antispasmodic effect, such as A.B.A., might overcome this danger."

The Use of Tubes or Catheters in the Ureters. Coffey inserts the tubes or catheters in bilateral transplantations to prevent compression of the ureters by edema and extravasated blood. Koch has given up catheters, as on each of the two occasions he used them they became blocked with phosphates on the fourth and sixth days respectively and had to be removed with much difficulty by cutting the ligatures with a pair of long scissors through a proctoscope.

For all other cases No. [illegible] or No. [illegible] rubber tubing has been used by Koch and, on the whole "has been fairly satisfactory but great care must be taken not to tie the fixation ligatures too tightly or the lumen of the tubes will be obliterated. This happened on one occasion and Koch had to reopen the abdomen six hours later, locate the sections below each [illegible] ligatures and apply others. [illegible] [illegible] recovered but "it is not an [illegible] the

particular care to see that urine is flowing freely from each tube before it is drawn into the bowel. The method of fixation he now employs is shown in Figs. 1004–1005–1006. Nitch points out

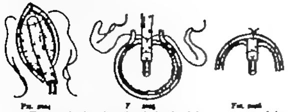


Fig. 1004. Fig. 1005. Fig. 1006.

Fig. 1004. The ureter has been drawn into the bowel and the stay suture passed through the muscular coat on each side of the incision.

Fig. 1005. Oblique transverse section showing ureter after it has been drawn into the bowel and the stay suture passed through the muscular coat.

Fig. 1006. The stay suture tied. (Nitch.)

Even rubber tubes cause trouble and anxiety, for they must irritate the ureter, and if they become blocked, syringing and the passage of wires to remove the obstructing phosphates or mucopus must cause some infection. If tubes become obstructed I think the best plan is to remove them at once either by traction or, if this fails, by cutting the ligature through a speculum.

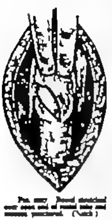


Fig. 1007. Bowel stretched over open end of rectal tube and mucosa punctured. (Nitch.)

As the catgut urine guide is so satisfactory in Stiles' operation it ought to be equally satisfactory in the Coffey operation and in my experience with tubes it would be infinitely preferable.

Embedding the Ureter. In embedding the ureter by the Coffey method the important points are (1) complete hemostasis to prevent compression by clot, and (2) care not to cause strangulation by a tight suture at the point where it enters the wall of the bowel.

Drawing the Ureters Into the Bowel. In Nitch's first few cases he followed Coffey's tube technic, in which the ureteric catheter or tube is attached to a tube in the rectum with a suture passed through the opening in the mucous membrane. As this was a weak spot in an otherwise clean operation Nitch, for some years, employed a method which is practically completely aseptic. After the rubber tube is fixed in the ureter a ureteral catheter is attached to its distal end. A curved hollow rectal tube is then passed by an assistant and guided to the site of anastomosis by the operator's hand within the pelvis. After using it as a support for dividing the muscular layer it is tilted up, and the lowest part of the incised wall of the bowel is so

held as to be stretched tightly over its open end (Fig. 1007). The mucosa is then punctured with a fine knife and the ureteral catheter attached to the ureteral tube passed through the opening into the rectal tube to be caught and withdrawn by the assistant until the end of the ureter is within the bowel (Fig. 1008). The opening in the mucous membrane is made just large enough to take the ureter so that no suturing is required. The stay suture is then passed through the muscular coat and tied.

Comment (Nitch). "Transplantation of one ureter at a time or simultaneous bilateral transplantation depends on the condition and age of the patient and the condition for which the operation is being performed.

"For malformations in young children, or as a palliative for inoperable carcinoma in aged and debilitated adults, the two-stage operation is probably safest. When the operation is preliminary to total cystectomy simultaneous bilateral transplantation is advisable, for the dangers of 3 operations and the time that must elapse before the cystectomy can be performed, are more to be feared than the slight additional risk of the double operation.

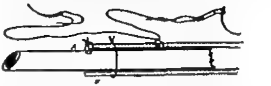


Fig. 1008. Nitch's method of fixing rubber tube in ureter. R. Fine rubber tube. U. Ureter. A. Fine catgut suture attaching divided end of ureter to tube but not entering lumen of tube. B. Circular ligature which must not be tied too tightly. C. Stay suture inserted in long axis of ureter to avoid injury to blood vessels.

"The chief disadvantage of the two-stage operation is the formation of firm and sometimes dangerous adhesions. It was owing to this that I lost what should have been a successful case, for in separating adhesions, the blood supply of a transplanted right ureter which had been functioning perfectly for a fortnight, was so damaged that it sloughed. When a two-stage operation is necessary I advise transplantation of the left ureter first, for the disturbance of the intestines and the injury to the peritoneum are less and subsequent adhesions are generally limited to that side. When the right operation is performed first the pelvic colon has an unpleasant way of falling downward and forward and forming with its mesentery an adherent sheet which must be separated before the pelvirectal junction can be exposed.

"For the delayed fistula operation single transplantation is, of course, essential."

Renal infections combined with dilatation of the ureters and kidneys are the chief causes of the immediate and late mortality. Out of Nitch's seven patients that were traced, four complained of intermittent renal pain and pyrexia. It is his belief, that the majority of survivors develop some form of renal infection, which, though silent and unsuspected for many years, ultimately determines their death.

The causes of death peculiar to the operation are:

1. Operative peritonitis, a complication which should not occur if the aseptic technic Nitch described is employed.

2. Peritonitis from sepsis at the site of transplantation, due to ascending infection or to leakage.

3. Sloughing of the ureter.

4. Various forms of chronic or acute renal infection.

The operation undoubtedly has a high mortality due to both technical and constitutional causes, but as it is intended to relieve physical and mental distress, and in curable cases of malignant disease, to permit of complete removal of the neoplasm, Nitch considers it is justifiable, no matter how high the mortality, when it brings relief and comfort to the survivors.

G. Grey Turner and James H. Saint,[1] have tabulated the pathologic changes in the kidneys and ureters together with renal functions in six cases of transplantation of the ureters. In five of these cases the renal function was good and in one case impaired on the left side. In two cases the renal function was good and in four cases impaired on the right side.

COFFEY'S OPERATION MODIFIED BY FURNISS

The essentials of this procedure consist in preserving the blood supply of the ureter by retaining its peritoneal attachment when freeing the portion of the ureter to be anastomosed. Furniss, citing Reuben Peterson, stressed the importance of keeping the opening into the intestine, through which the ureter is to be implanted small and of cleansing the bowel after the patient is anesthetized.

Step 1. Spinal anesthesia unless contraindicated.

Step 2. Place a rectal tube in the lower bowel.

Step 3. Make a low median incision.

Step 4. Close the sigmoid, above the point of anastomosis by gently clamping it with a rubber-covered intestinal clamp.

Step 5. Attach a needle connected to an irrigator filled with saline solution.

Step 6. Irrigate the bowel. Connect the needle to an air-pressure apparatus and dry the intestine by blowing air into it; this drives out through the rectal tube any fluid that may have been left after the irrigation. Furniss finds that this is as efficient as Coffey's method of packing with gauze, and is more easily carried out. Only one ureter is to be implanted at a time. It is less of an operation, and should it prove that the particular patient has a tendency to develop an ascending infection shortly after operation, this complication may be better handled than if both ureters are implanted at one time. It matters little which side should be done first. To prevent narrowing of the intestine, the ureters should be placed at different levels, at the right lower.

Step 7. Place the patient in a moderate Trendelenburg position. Pack off the intestines.

Step 8. Locate the right ureter where it crosses the iliac vessels, open the peritoneum on the posterior abdominal wall, just to the outer side of the ureter

[1] British Jour. Surg. Vol. 23, No. 92, 1936.

Carry the incision parallel to the ureter [illegible] inches distant, to the broad ligament (Fig. [illegible]).

Step 9. Clamp the ureter doubly and divide it between the clamps.

Step 10. Lift the ureter up [illegible] the upper clamp and incise the peritoneum along its inner [illegible] back the dissection was begun.

Step 11. Shift the ureter over toward the rectum and choose the site of the implantation into the rectum. This should be at a point where the ureter may be implanted [illegible].

Fig. [illegible]. The large intestine shows the pelvic loop is greatly elongated [illegible] [illegible]. (Fowler.)

Step 12. Extend the last part of the peritoneal incision to the rectum, so that the ureter may, after the anastomosis, be covered with peritoneum and excluded from the peritoneal cavity. The incision into the rectum should be approximately one and one-half inches long, running from an outer side toward the median line and extending through the peritoneal and muscular coats to the mucosa (Figs. [illegible]).

Step 13. Remove the clamp from the ureter and pass [illegible] suture of No. [illegible] ten-day chromic catgut through the entire thickness of its anterior wall and tie it firmly. Pass [illegible] pointed trocar into the intestinal lumen. Enlarge the opening into the mucosa to make the subsequent step easier.

Step 14. Thread the suture that has been attached to the ureter into the eye of the needle and by withdrawing the needle and pulling the suture the ureter is drawn into the intestine. This suture is then transferred to a curved [illegible] needle, and by passing this through [illegible] portion of the peritoneal and muscular coat of the intestine and tying it, the ureter is firmly anchored to the interior of the rectum (Fig. [illegible]).

Step 15. Place two [illegible] sutures over this which will insure against leakage at this point.

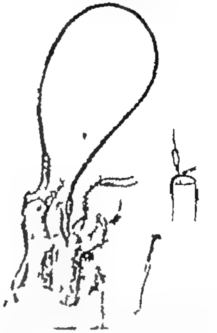


Fig. [illegible]. [illegible] (Fowler.)

Step 16. Fold the peritoneal and muscular coats of the rectum over the ureter with [illegible] sutures of No. [illegible] ten-day chromic catgut. Some of these sutures should include [illegible] of the peritoneum that was dissected up with the ureter. Care is taken not to include the ureteral wall in any of these sutures (Fig. [illegible]).

Step 17. Close the primary incision, made to isolate the ureter, and the upper broad [illegible] is closed over the ureter so that it is excluded from the peritoneal cavity.

Step 18. Close the abdominal wound without drainage.

Comment. Fowler points out that the left ureter is not so closely adherent to the peritoneum, and, therefore, it is somewhat more difficult to [illegible] it than on the right.

Fig. [illegible]. Operation completed. (Fowler.)

OPERATIONS ON THE URINARY BLADDER

Anatomic Considerations. The [illegible] of the peritoneum under normal and [illegible] of [illegible] and distention [illegible] (Figs. [illegible]). The upper part of the base of the bladder is covered by the peritoneum of the [illegible] pouch, the lower part is uncovered by peritoneum and [illegible] separated from the rectum in the male by the seminal vesicles and vasa deferentia and in the female by the cervix uteri and upper part of the vagina. The [illegible] of Retzius [illegible] the area below the peritoneal reflection, it is filled by [illegible] connective tissue [illegible] and adipose tissue and communicates laterally with the general extraperitoneal space. The neck of the bladder [illegible] the area surrounding the urethral orifice and adjacent to the superior surface of the prostate gland. When the bladder is filled with fifteen to twenty ounces of liquid the line of reflection lies usually about two inches above the symphysis pubis so incision in the linea alba below this point will expose the bladder without injury to the peritoneum. The trigone [illegible] triangular area in the interior of the bladder bounded by the ureteric orifices laterally and the urethral opening at the base. Between the ureteric orifices the mucosa [illegible] slight fold by the [illegible] bar of muscle.

The arterial supply of the bladder consists of the superior and inferior vesical branches of the anterior division of the internal iliac (hypogastric) artery. The [illegible]

Fig. [illegible]. Median section through the pelvic organs of the male. (Spalteholz.)

[illegible] veins drain into the prostatic plexus situated around the neck of the bladder and terminate by three or four veins into the internal iliac vein.

The lymphatics are arranged in two networks (in the muscle and beneath the [illegible]), the efferent vessels emptying into the internal iliac lymph nodes.

The nerve supply consists of:

( ) Sympathetic fibers from the hypogastric plexus and

(b) Autonomic (parasympathetic) from the nervi erigentes.

SUPRAPUBIC ASPIRATION OF THE BLADDER

Percutaneous Vesicae

This is an emergency or temporary expedient for [illegible] retention.

The puncture point is made in the median line just above the symphysis pubis. A trocar and cannula are the instruments used (Fig. [illegible]) the latter having a caliber of about No. [illegible] French catheter and it should have a slight curve. An aspirating syringe (about [illegible] cm. long and of about [illegible] mm. bore) may occasionally be used to advantage. Infiltrate the point of entry of the trocar with novocaine solution ([illegible] per cent). The course of the instrument is to be directed forward and downward and the intervening tissue is penetrated with a quick thrust. After the bladder is entered (giving of yielding bladder wall) the trocar is withdrawn and the urine is permitted to drain off through the cannula

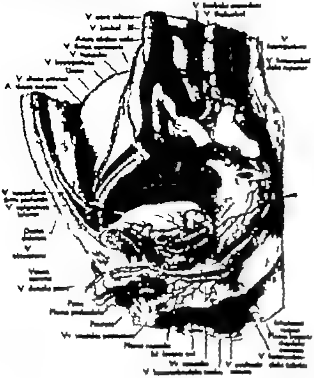


Fig. [illegible]. Veins of the male pelvis. (Spalteholz.)

which is withdrawn and the catheter retained in place as long as desired (adhesive plaster fixation, suture to skin).

Do not draw off the urine too quickly lest intravesical hemorrhage supervene. Always leave a small quantity of urine in the bladder. Long continued catheter drainage is practiced (possibility of perivesical infection); suprapubic cystostomy avoids this danger. Cases on record show where the trocar injured a loop of bowel before reaching the bladder.

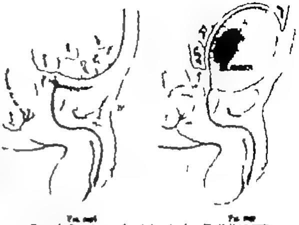


Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Sagittal section through the male pelvis. The bladder is empty.
Fig. [illegible]. Position of the peritoneum ... [illegible] ... the bladder [illegible]

William E. Lower described a trocar and cannula for suprapubic drainage of the bladder[a] as follows:

In certain cases of retention of urine due to tight stricture and in many cases of hypertrophy of the prostate, severe and often fatal consequences have resulted from attempts to empty the bladder by catheterization with metallic instruments when soft catheters have not been available or could not be used. As many of these cases of retention occur in the practice of the general practitioner who is not equipped with proper instrumentation, and who is often far removed from surgical aid, some other method of relief is required. Although most practitioners are timid about the use of the trocar yet they do not hesitate to forcibly push the extremely sharp catheter through a stricture or prostate in spite of the facts that this procedure may produce a severe hemorrhage, and that as a rule it does not relieve the patient. As a result the catheter becomes clogged with blood, and even if relief is secured it is generally but temporary. A better and safer procedure, which will give prolonged relief, is the use of the trocar and

[a] Surgery, Gynecology and Obstetrics, Vol. XVIII, No. [illegible], 1914.

cannula herein described (Fig. [illegible]). This cannula has a metal collar so manipulated by a thumb screw that its length can be regulated so as to avoid the possibility of forcing the trocar beyond the necessary distance for relief.

By the use of a local anesthetic, or without any anesthetic even, the trocar and cannula may be forced into the bladder at a point sufficiently distant from the pubes to avoid puncturing the plexus of veins which lies just behind the pubic bone (Fig. [illegible]). The trocar is then withdrawn, and a No. [illegible] soft rubber catheter is inserted through the cannula into the bladder (Fig. [illegible]). The cannula is withdrawn (Fig. [illegible]) and the bladder emptied through the catheter which is allowed to remain. The retained catheter can be held in place by adhesive plaster, the end being plugged or compressed until relief is again needed. The catheter may remain in place for days if necessary without doing any harm and in the meantime the patient can be transferred for operation or further treatment. It may happen that after several days of suprapubic drainage the patient will again be able to void urine. This method offers a more comfortable way of securing continuous drainage of the bladder as a preparation for prostatectomy than the insertion of a catheter through the urethra as the latter is generally irritating and disturbs the patient greatly.

Fig. [illegible]. Suprapubic trocar.

"If no soft catheter of the proper size is available, the cannula itself may be retained if ... fastened with tape inserted through the small slots in the collar (Fig. [illegible]). I have never seen a permanent fistula follow the use of the trocar."

SUPRAPUBIC CYSTOTOMY AND CYSTOSTOMY

(Sectio alta. Epicystotomy)

This operation consists of an extraperitoneal incision into the bladder immediately above the symphysis pubis through the prevesical space and below the peritoneal reflection. Fill the bladder with saline solution before the operation is begun. The Trendelenburg position is of aid.

When drainage is established cystostomy is spoken of; this may be either temporary or permanent (Fig. [illegible]).

The operation is essentially the same as cystotomy except that a drainage tube of one type or another is permitted to remain in the bladder for as long as necessary to secure drainage. Either a de Pezzer self-retaining catheter (Fig. [illegible]) is used, around which one or two of Lembert sutures are placed and inverted (like in a) Kader gastrostomy

Fig. [illegible]. Lower's trocar and cannula with metal collar.

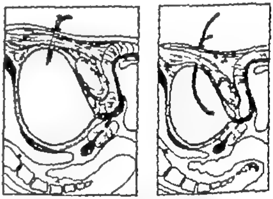


Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Introduction of Lower's trocar.
Fig. [illegible]. Introduction of catheter through cannula.

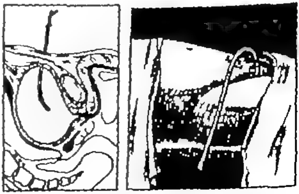


Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Cannula withdrawn. Catheter remains.
Fig. [illegible]. Cannula fastened and retained by tape through small openings in the metal collar.
(Courtesy of Dr. Wm. E. Lower.)

operation after the tube has first been fixed to the bladder wall by single catgut stitch embracing the entire thickness of the bladder wall, or drainage is secured by means of one or two rubber tubes attached to the edges of the vesical and abdominal incision by catgut or linen sutures. The intravesical ends of the tubes should project into the bladder sufficiently to drain off the urine and not impinge upon the floor of the bladder; the distal portions of the tubes projecting through the dressings are attached to other tubes by glass couplings to carry

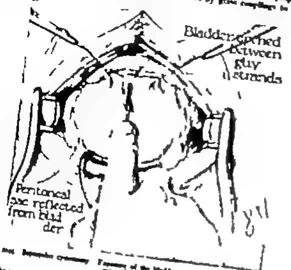


Fig. [illegible] Suprapubic cystotomy. Exposure of the bladder. Introduction of traction or guy sutures.

off the urine. For security the tubes should also be attached to the skin margins [illegible] sutures.)

Cystotomy Through Longitudinal Incision

Step [illegible] Incision. Divide the skin, superficial and deep fasciae down to the anterior sheath of the rectus abdominis muscle, [illegible] to the left or right of the median, as preferred, from the superior border of the symphysis pubis to as far up as seems indicated (usually about three inches). Open the rectus sheath, retract the recti and pyramidalis muscles. Expose the peritoneum and prevesical fat (Fig [illegible]).

Step [illegible] Push the peritoneum gently upward and out of the way. The partially filled bladder is easily recognized by its bluish pink color, by the particular [illegible] of its muscle fibers, by the presence of large branching veins coursing on its surface and the firm elastic sensation the viscus imparts to

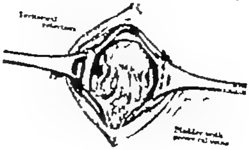


Fig. [illegible] Exposure of the anterior wall of the bladder. [illegible]

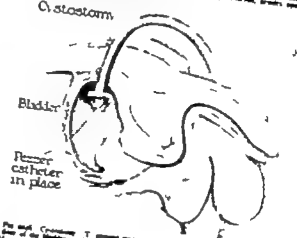


Fig. [illegible] Cystostomy. [illegible] the catheter should not [illegible] the floor of the bladder or the prostatic gland. The catheter should be attached to both the bladder and the abdominal wall.

the palpating finger (fluid cushion sense) (Fig [illegible]). Pack off the surroundings with adequate lap sponges.

Step 3. Introduce two traction sutures one on either side of the bladder (Fig [illegible]). These are of catgut and penetrate the muscular wall; they are placed at the midpoint of the exposed bladder about [illegible] cm. from the proposed line of incision. The bladder is entered with [illegible] scalpel thrust into the viscus between the traction sutures. As soon as the bladder [illegible] entered, suction apparatus rids the field of the escaping fluid and [illegible] finger hooking the upper border of the incision brings the opened bladder into the wound. The incision may be enlarged upward or downward according to indications present.

Step 4. After the intravesical part of the operation [illegible] completed the opening in the bladder is closed around drain with interrupted catgut sutures; these encompass the entire thickness of the bladder [illegible] except its mucous membrane. As many sutures as are necessary are used [illegible]. A row of Lembert sutures are superimposed over the first suture line (Fig [illegible]).

Step 5. Close the abdominal wall in layers. A small cigarette drain or two is placed in the space of Retzius, and another in the upper angle of the wound between the muscles.

Cystotomy Through Trendelenburg Kelly Transverse Incision

Liston as far back as [illegible] suggested the use of [illegible] transverse incision. Trendelenburg ([illegible]) popularized the procedure.

Step [illegible] Distend the bladder. Trendelenburg position. Divide the skin, superficial and deep fasciae. Expose the sheaths of the recti abdominis muscles. Ligate and divide the blood vessels coming to view. A transverse incision from six to eight inches in length is made; it should be slightly curved, with its concavity upward, in the suprapubic field and extend from one external inguinal ring to the other.

Step [illegible] The anterior sheath of the recti muscles is incised transversely and the recti and pyramidalis muscles thoroughly exposed and divided transversely. Engage these muscles in sutures the ends of which are left long to counteract the retraction of the muscular masses, which is inevitable. The ends of the sutures left long will greatly aid in bringing them down. [illegible] is to be effected. Some surgeons make this incision longitudinally to avoid injury to the deep epigastric vessels. Divide the transversalis fascia and expose the peritoneum.

Step 3. Strip off the prevesical fat and peritoneum from the upper surface of the bladder and identify it by the characteristics mentioned above. An assistant now holds the peritoneum out of the way by [illegible] broad retractor.

Step 4. Protect the surroundings with gauze packs. Incise the bladder transversely about the level of the upper border of the symphysis pubis. If longitudinal incision is decided upon, the technic described above is used. Evacuate the bladder contents with the suction apparatus. Grasp the edges of the incision with traction sutures as above.

Step 5. The intravesical procedure having been completed the bladder wall is sutured as outlined above around [illegible] drain.

Step 6. Lower the patient from the Trendelenburg position. Close the abdominal wall meticulously. Draw Retzius' space. The longer ends of the su-

tures holding the recti muscles are brought down and united to the muscular aponeurosis and fasciae below.

Comment. If drainage of the bladder is to be maintained cystostomy is practiced. If the peritoneal cavity is accidentally opened it should be promptly closed. Bladder retractors may be used to hold the incision open (Fig [illegible]). Blood vessels of the bladder wall should be ligated to avoid the loss of blood.

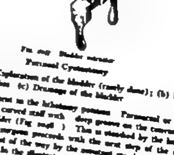


Fig. [illegible] Bladder retractor.

Perineal Cystotomy

Indications. ( ) Exploration of the bladder (rarely done); (b) Removal of calculi and foreign bodies; (c) Drainage of the bladder.

Step [illegible] Place the patient in the lithotomy position. Paravertebral or low spinal anesthesia. Pass [illegible] curved staff with [illegible] deep groove on the convexity of the curve, into the bladder (Fig [illegible]). This is steadied by the hand of the assistant while the surgeon proceeds with the next step of the operation. Keep the scrotum out of the way by the assistant steadying the staff, pull it upward as shown in the illustration. The curved portion of the staff is pushed toward the perineum, thus bringing the membranous urethra toward the front. This is accomplished by the assistant, holding the staff, inclining the hand toward the abdomen.

Step 2. Feel the staff resting in the membranous urethra. Make [illegible] vertical incision about two inches in length from above downward along the raphé of the perineum extending to about one-half inch in front of the anus. The incision is deepened until the staff is exposed. This opens the membranous urethra.

Step 3. Introduce into the wound [illegible] probe-pointed gorget (Fig [illegible]) which is placed accurately into the groove of the staff; this is brought forward by the surgeon's left hand and then pushed along the groove toward and upward

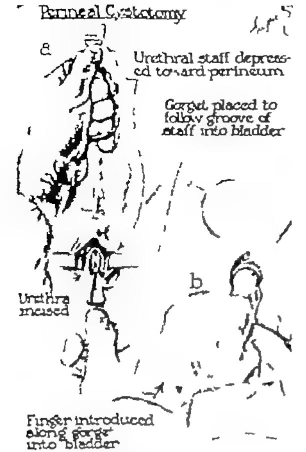


Fig. [illegible]. Perineal cystotomy. [illegible] [illegible] staff is depressed [illegible] held by assistant [illegible] [illegible] [illegible] gorget into the groove of the staff. [illegible] [illegible] [illegible] gorget enters bladder. Forefinger of left hand introduced into bladder along gorget.

toward the bladder. A gush of urine announces that the gorget has entered the bladder. It is left in position, while the staff is withdrawn. The forefinger of the left hand is now introduced into the bladder along the gorget by [illegible] boring, dilating motion. Exploration, removal of stones and drainage may now be accomplished.

Comment. In the early days of surgery this procedure was extensively practiced. The incision was either median or lateral. The suprapubic approach is now practiced by most surgeons; nevertheless this procedure finds its indications when [illegible] project into the prostatic urethra—or when prostatic hypertrophy has complicated the condition or in removing foreign bodies.

RUPTURE OF THE URINARY BLADDER

Rupture of the urinary bladder usually occurs in instances of injury to the abdomen when the bladder is distended. The diagnosis must be promptly made and proper therapy instituted if good results are to be obtained. The mortality rate is high.

Methods of Diagnosis. (A) Excretion urography which consists of taking X-rays seven or eight minutes after an intravenous injection of [illegible]. (B) If catheterization reveals the presence of blood, inject about [illegible] ounces of normal salt solution into the bladder. If none, or very little, of the solution is returned, the bladder is ruptured.

Cystoscopy and the introduction of air into the bladder are to be deprecated (shock, peritonitis, air embolism).

In the large majority of cases the rupture is located on the posterior aspect of the bladder dome and is intraperitoneal.

Operation for Intraperitoneal Rupture of the Bladder

Step 1. Make [illegible] good-sized paramedian incision below the umbilicus down to the pubic bone.

Step 2. Open the peritoneum and sop up the urine with lap sponges, or still better use [illegible] good suction apparatus.

Step 3. Pack the intestines out of the way. Open Retzius' space by

Step 4. stripping away the peritoneum from the upper anterior surface of the bladder by means of gauze dissection.

Step 5. Make an incision into the bladder as for suprapubic cystostomy. Insert the left index finger into the bladder and explore. Locate the laceration in the bladder wall. Repair it with interrupted catgut sutures which penetrate the bladder [illegible] all musculature. (Figs. [illegible].)

Step 6. Institute suprapubic bladder drainage; this is of utmost importance. Introduce [illegible] de Pezzer catheter into the suprapubic incision in the bladder and close the bladder around it (see suprapubic cystostomy, p. [illegible]).

In the presence of peritonitis insert [illegible] suprapubic peritoneal drain. Drain the space of Retzius with [illegible] cigarette drain.

A suction apparatus should be employed to keep the bladder emptied during the period of healing.

[illegible]

Fig. [illegible]

Fig. [illegible]

Fig. [illegible]. Combined intra- and extraperitoneal rupture [illegible] the bladder. First layer of [illegible] [illegible] [illegible] [illegible] [illegible] the [illegible] of the [illegible] [illegible].

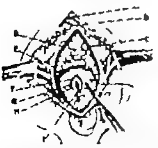


Fig. [illegible]

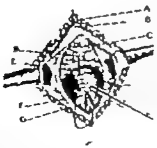


Fig. [illegible]

Fig. [illegible]. [illegible] rupture [illegible] the bladder. [illegible]

Extraperitoneal Rupture of the Bladder

In most instances this occurs in conjunction with [illegible] fractured pelvis. The treatment consists of performing [illegible] suprapubic cystostomy and draining the space of Retzius. (Figs. [illegible].) In some cases the bladder may be closed.

If the anterior wall [illegible] the site of injury the drainage tube is inserted through the wound and the bladder closed snugly around the tube. The urethra should be examined for possible injury by introducing [illegible] catheter into the external meatus before concluding the operation.

In ruptures which involve both the intra- and extraperitoneal parts of the bladder the procedure recommended for intraperitoneal rupture is followed. (Figs. [illegible].)

OPERATIONS FOR VESICAL CALCULUS (LITHOTOMY; LITHOLAPAXY)

Historical Notes. Suprapubic Lithotomy. Perineal Lithotomy. In the early [illegible] of the Indians, references are found to cutting operations for stones in the bladder. In the era of Hippocrates there were [illegible] [illegible] who specialized in cutting for stone. This became [illegible] art and often became [illegible], usually handed down from father to son. All of these operations were done by the perineal route. Celsus about [illegible] years ago described the operation [illegible]. [illegible] perineal lithotomy in children between the ages of nine to fourteen years. [illegible] [illegible], was the method of Celsus. [illegible] described it as "cutting on the gripe" [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] "stone cutters" [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] (lithotripsy) [illegible] [illegible] [illegible] [illegible] Lateral perineal lithotomy was described by [illegible] [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] "[illegible] of Mystery" [illegible] [illegible] [illegible] "stone cutters," [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] suprapubic operation [illegible] [illegible] [illegible] the bladder [illegible] "stone cutters." [illegible] [illegible] [illegible] [illegible] [illegible] lateral lithotomy [illegible] [illegible] [illegible] [illegible] to an English surgeon, Cheselden ([illegible]) who at the time of his death had [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] mortality of only [illegible] per cent. [illegible] John Dott of Amsterdam, [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] pubic [illegible] [illegible] [illegible] [illegible]. The higher mortality as compared with the perineal method caused the operation to become obsolete between [illegible] and [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

Litholapaxy (Lithotrity). [illegible] [illegible] the author of the statement that lithotrity was practiced by the ancients. According to this authority [illegible] of [illegible] [illegible] that the procedure was performed in the [illegible] century. [illegible] and [illegible] [illegible] [illegible] the method in the [illegible] century. The method was [illegible] [illegible] [illegible] [illegible] [illegible] who did not perform the operation himself. Civiale, [illegible] French surgeon,

[illegible] practiced and advocated the method and published [illegible] work on lithotrity. The development (devices of instruments for crushing stones) was enhanced by [illegible] of Scotland [illegible], and Amussat and LeRoy d'Etiolles in [illegible]. The first operation of passing an instrument through the urethra into the bladder, engaging the stone and crushing it, was done by Civiale, January [illegible]. In [illegible] [illegible] introduced the method in [illegible] and in America, [illegible]. In England [illegible] [illegible] [illegible] the fragments of the crushed stone were [illegible] from the bladder by [illegible] apparatus. [illegible] introduced an instrument [illegible] brings the fragments of stone from the bladder into [illegible] chamber. [illegible] were then the accepted practice until [illegible], when Henry J. Bigelow of Boston introduced the operation of lithotrity in one sitting, which he named "litholapaxy."

Suprapubic Lithotomy

This operation is practically that of suprapubic cystotomy plus the removal of the stone. If the calculus is a large one the transverse incision is to be preferred as it affords more room. Do not subject the bladder to undue trauma by endeavoring to deliver a large stone through a small opening in the bladder. The stones should be removed by appropriate forceps. Direct visualization through the suprapubic opening prevents overlooking of stones. In the presence of infection, drain. If the stone is in a diverticulum it is best to do a diverticulectomy.

Perineal Lithotomy*

The operation consists of opening the prostatic urethra and vesical orifice by an incision extending across the surface of the left side of the perineum and entering the prostatic urethra by further incisions in the line of the first one. The prostatic urethra is sectioned, as [illegible] part of the prostate and the outlet of the bladder. Through the opening thus produced the stone is extracted. Although the [illegible] procedure in the days of yore, this operation is rarely, if ever, practiced now [illegible] the results in expert hands were remarkable ([illegible] consecutive cases without a death by Alan Smith of Baltimore) the operation was abandoned because of the frequent occurrence of urinary incontinence.

LITHOLAPAXY (LITHOTRITY)

Bigelow Operation

As stated above, prior to developing the procedure to be described, the custom prevailed of crushing the stone by frequent sittings for crushing, allowing the patient to pass the débris from the bladder. The mortality was high and patients [illegible] suffered more or less constitutional reactions. Bigelow of Boston showed that these untoward results were due to the [illegible] of the bladder by sharp fragments of calculus remaining for hours or days in the bladder before finding their way to the outer world. These [illegible] could be obviated, Bigelow claimed, if the fragments were removed at one sitting. The instruments Bigelow devised to obtain these results were stronger in construction than those produced before and so designed that they would not injure the bladder. The addition of a powerful evacuating bulb through which complete evacuation of the fragments was accomplished was [illegible]

*The operation is here alluded to for its historical interest.

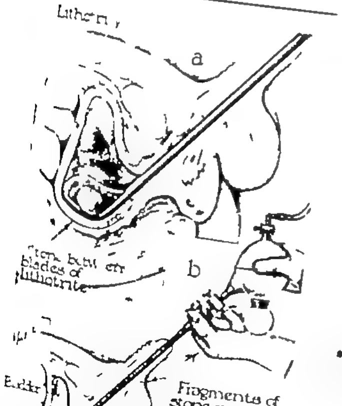


Fig. [illegible]. Lithotrity. [illegible]

most helpful. The term litholapaxy was coined by Oliver Wendell Holmes. Among others who have made important contributions to the development of the operation may be mentioned Guyon, Chismore, Freyer, Young, Keegan and others.

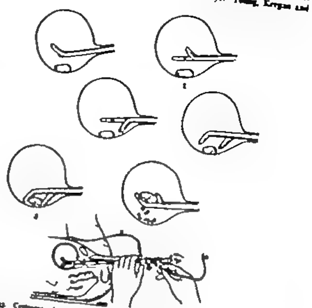


Fig. [illegible]. Cystoscopic lithotrity. [illegible]

Dorsal decubitus.

Step [illegible]. Anesthesia. General, spinal or caudal; general anesthesia is preferred for children. Local anesthesia, 5 cc. of 4 per cent [illegible] solution introduced into the bladder and equal amounts are instilled into the posterior and anterior urethra. Fill the bladder with 200 cc. of salt solution.

Step [illegible]. Introduce the lithotrite into the bladder (Fig. [illegible] a). A new surgical instrument now enables the operator to perform this operation under direct

[illegible] at the back of the lithotrite. (Fig. [illegible].) Do a meatotomy when the instruments cannot be passed with ease. Avoid injury to the deep urethra (particularly in prostatic hypertrophy) during the passage of the instrument. Let the instrument proceed by its own weight along the urethra until it reaches the base of the bladder (its most dependent part), on which it is permitted to rest.

Step 3. Unlock the instrument; open the blades by withdrawing the male blade an inch or more, depending upon the size of the stone; the female blade is held steadily in position.

Step 4. Close the blades; often the stone will be found between them. Lock the lithotrite and lift it slightly off the base of the bladder.

Step 5. Crush the stone by screwing the male blade home.

Step 6. Unlock the lithotrite again. Engage the large fragments—crush it. Repeat this several times. In case the stone is not promptly found it must be searched for. This is accomplished by opening the blades of the instrument and turning them at an angle of 45° to the left and right and closing the blades. If the stone is still elusive, depress the handle of the instrument toward the horizontal position between the thighs and push it about an inch or so toward the posterior surface of the bladder and search persistently to the right and left until the aim is accomplished.

In cases where the stone is located behind an enlarged prostate, depress the handle of the lithotrite and turn it around on its axis so that its beak points to the trigonum vesicae but with which it should not come in contact. Open and close the blades as outlined above and engage the stone. Avoid injury to the mucous membrane of the bladder. Continue the crushing of fragments persistently until no other fragment is found; the instrument is then withdrawn. Make sure that the blades are securely approximated before you attempt the withdrawal of the instrument.

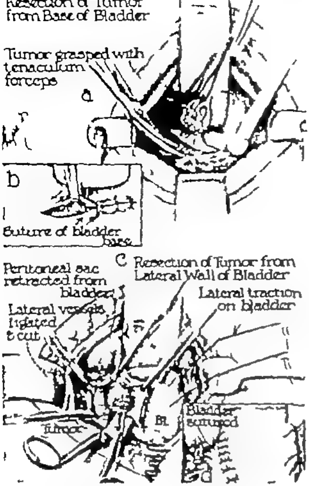
Step 7. Proceed to evacuate the crushed fragments by passing the evacuating tube; evacuate the bladder contents through it (Fig. [illegible] b). The evacuating tube should be passed to the most dependent part of the bladder, holding the evacuating tube in the left hand and the evacuator in the right. Turn the beak of the instrument into various positions of the bladder; do not overlook the pouch behind the prostate. Evacuate the bladder thoroughly. If a large fragment is discovered to have been left behind, the lithotrite should be reintroduced and the procedure of crushing repeated. Avoid sucking up a portion of the mucous membrane of the bladder into the evacuating tube.

Contraindications for Litholapaxy

H. Cabot[1] gives the following contraindications for litholapaxy:

(1) Disproportion between bladder and stone (large stone, small bladder).
(2) A stone formed around a foreign body of metal.
(3) A urethra which is too small to admit a lithotrite.
(4) Ankylosis of the hip.
(5) When the stone is located in a dilated prostatic urethra.

[1] [illegible] M. A., Dec. [illegible], p. [illegible]



[illegible]

OPERATIONS FOR TUMORS OF THE BLADDER

Nonmalignant Tumors

In these cases it is best to excise the tumor and the mucous membrane surrounding it (Fig. [illegible] a, b)

Step 1. Place the patient in the Trendelenburg position. Suprapubic cystotomy. Thorough exposure and adequate illumination are essential.

Step 2. Grasp the tumor with a pair of forceps. Circumscribe the area to be excised in the form of an ellipse. Remove the mucous membrane and tumor from the underlying musculature as shown in the illustration. Bleeding is often free. Rapid sponging (suction) and compression with ligation of the bleeding points secure hemostasis.

Step 3. The wound remaining, after the removal of the tumor, is closed with interrupted catgut sutures. The nearer the tumor is to the neck of the bladder the more difficult will be its excision; the nearer to the vertex and the lateral walls the simpler its ablation. Introduce a catheter. Close the suprapubic opening in the bladder. Drain the space of Retzius. Dress the wound.

Resection of the Bladder Wall

In this operation the entire thickness of the bladder wall is taken away with the tumor resting upon it.

Historical Notes. Anterior and Lateral Walls. Sonnenburg, in [illegible], was first to resect a portion of the entire thickness of the bladder wall. The operation was done by the abdominal route. Marion, in [illegible], did the first partial resection of the bladder through the retroinguinal region.

Step 1. Trendelenburg position. Expose the bladder as described in the above procedure.

Step 2. Separate the bladder freely from the posterior surface of the pubes.

Step 3. Strip the peritoneum out of the way.

Step 4. Open the bladder in healthy territory away from the tumor mass.

Step 5. Engage the edges of the wound with Allis' forceps. Define the extent of the tumor by palpation and inspection.

Step 6. Excise the tumor with scissors, curved on the flat, taking a considerable margin of healthy tissues with the tumor (Fig. [illegible] c). Large portions of the bladder may thus be removed effectively. Hemostasis must be perfect. Avoid implantation metastases by meticulous attention that tumor particles do not come in contact with the bladder surfaces. When the peritoneum has to be entered, it should be closed after removal of the tumor.

Step 7. The defect in the bladder wall should be repaired by interrupted catgut sutures, in either the transverse, vertical or irregular position depending upon the configuration of the defect (Fig. [illegible] d). Drainage by (a) de Pezzer catheter (b) Retzius' space drainage.

Tumors of the Base of the Bladder

Here again the operation may be extra or transperitoneal depending upon existing exigencies. In principle the operation consists of opening the bladder

longitudinally through a median incision. Good exposure (wide retraction) and adequate illumination are indispensable prerequisites for thorough work. The extent of involvement determines whether one or both sides of the bladder are to be freed accurately. The blood vessels supplying the particular affected section of the bladder are doubly ligated and divided. Dissect the bladder bluntly from its contiguous structures (peritoneum, rectum, ureters, vas deferens and seminal vesicles). Preliminary catheterization of the ureters in order to avoid injury to these structures and facilitate their recognition is of value. The base of the bladder is excised by a wide, healthy margin surrounding the affected portion. If a ureter has to be divided, its reimplantation into the reconstructed bladder may have to be done. If there is very extensive involvement, the question of total or subtotal cystectomy may have to be considered. The closure of the defect requires considerable ingenuity and resourcefulness. The surgeon will have to be conversant with the principles underlying plastic surgical procedures; the better equipped he is in that direction the better his operative results will be. A de Pezzer catheter is introduced into the reconstructed bladder around which the bladder wall is sutured. Drain the space of Retzius.

Tumors of the Trigone

When the tumor involves the trigone or ureteral orifices, transplantation of the involved ureter is usually indicated. Do ureteral catheterization whenever possible. For circumscribed tumors involving the ureteral orifices, the Albarran operation is advisable. Transverse cystotomy is done. An incision is made through the healthy mucous membrane surrounding the tumor including the ureteral opening. The tumor is caught with proper forceps; the mucous previously made is deepened with sharp pointed scissors through the muscular wall of the bladder. The ureter is included at the muscular tissue, and by further dissection, a pedicle is formed by the ureter. An incision is now made through the wall of the ureter beyond the tumor and a fine suture of catgut is passed through it. The ureter is now completely divided across and another similar suture is passed through its wall opposite the first. The portion of the wall of the bladder carrying the tumor is now resected. The ureter is drawn into the bladder by means of two catgut sutures previously introduced. The ureter is now split with fine scissors so as to form a right and left flap. The catgut sutures are picked up again and the needles carry them through the entire thickness of the bladder wall on each end of the lower side of the wound. The sutures are tied. When no catheter can be passed into the ureter, the growth is first resected, the ureter looked for and isolated.

The removal of tumors about the trigone showing a high operative mortality make the use of electrosurgery and X-ray preferable.

Electrosurgical Methods in the Treatment of Tumors of the Bladder

In expert hands localized tumors about the trigonum vesicae may be effectively destroyed by electrosurgical methods via the urethra.

For the purpose of average experience, proper exposure is essential and it is best to resort to wide opening of the bladder and thorough electrocoagulation of the neoplasm. It must be remembered that too much tissue destruction is just as bad as too little.

Step 1. Ascertain the position of the neoplasm by cystoscopy. Spinal anesthesia usually suffices. Place the patient in position as for cystotomy. An indifferent electrode is snugly applied to the sacrum.

Step 2. Perform suprapubic cystotomy.

Step 3. Evacuate the bladder thoroughly (suction). Retract efficiently; expose the tumor. Traction should not be exerted laterally on the bladder but vertically (cephalocaudal) (Oscar Kaletsky). This pertains particularly to cases where the tumor is situated behind the trigonum vesicae.

Step 4. Coagulate the protruding tumor (papilloma) with an appropriate sized, disc-shaped electrode and proper amperage sufficiently but not too intensely. Experience here is the best guide. Work under ocular guidance. The interior of the bladder should be thoroughly illuminated by appropriately projected light. To ascertain the depth of heat penetration an assistant introduces a finger or two into the patient's rectum or vagina respectively and reports to the surgeon the intensity of the heat transmitted during the coagulating process. There are no formulae for the intensity or duration of the current to be used. Observe the extent of marginal action of the active electrode, comply this with the reports of heat transmission to the assistant's finger and then gauge the necessary degree of current required for effective electrocoagulation. As a general proposition, however, when the base of the tumor has been coagulated down to the level of the bladder wall and its base appears dry the assumption is that the coagulating process is sufficient.

Pedicled tumors may be removed after first carbonizing them, by detaching the pedicle with the diathermy knife (resection) and finally by coagulating the base of the neoplasm.

Voluminous tumors may be attacked by coagulating the superficial segments, then cutting away the coagulated sections and again coagulating until the base of the tumor is reached.

Step 5. Close the abdominal wall. Drain the bladder (large de Pezzer catheter) (vide supra pp. [illegible].)

Comment. Radium is advocated by some in tumors of the bladder (either seeds through a suprapubic cystotomy). Joseph Muir implants radon through an instrument devised by him enabling the surgeon to enter the bladder per urethram. A combination of electrocoagulation with radium may be used in selected cases.

TOTAL EXTIRPATION OF THE BLADDER (CYSTECTOMY)

Historical Notes. The first cystectomy was done by Bardenheuer in [illegible]. In [illegible] the first successful operation was done by Pawlik in the following manner. A woman, aged [illegible] years, had been operated upon for a small vesical tumor by Pawlik one year before. Recurrence took place. The bladder was extirpated by two different operations. In the first of these the ureters were implanted in the upper end of the vagina. When these wounds had healed and the urinary stream had been successfully diverted, the second operation was carried out then.

The bladder was filled with [illegible] of [illegible] solution. It was then exposed above the symphysis and stripped of its peritoneal investment. The remainder of the bladder was enucleated. The anterior wall of the vagina was incised, the bladder drawn through this incision just above its outlet and removed. The posterior and

of the urethra was then connected by suture with the anterior wall of the vagina in front, and its posterior wall behind. A reservoir was thus formed out of the vagina into the upper end of which the ureters entered, and the lower end of which was in continuity with the urethra. The woman recovered and lived for fifteen years.

In 1903, Watson proposed bilateral lumbar nephrostomy and tying off of the ureters close to the renal pelvis as a preliminary step to total extirpation of the bladder. In 1905, Estersley suggested as a preliminary step to total cystectomy implantation of both ureters into the loin as done by Le Dentu, Poissi, Bazin, Schmiedt and others. While Young "never felt justified in carrying out an operation of total cystectomy," recent literature shows some encouraging results reported by other observers.

Earl M. Keshi in an article on "Total Cystectomy and Ureteral Transplantation in Malignant Conditions of the Bladder"[1] remarks that Edwin Beer, Quinby and Wilson have pointed out that removal of the bladder with a malignant tumor is not a very formidable procedure. Cystectomy would, no doubt, be the popular treatment for most bladder malignancies if it were not so difficult to dispose of the urine.

European surgeons have long been in favor of cutaneous ureterostomy. In this country Edwin Beer and Hugh Cabot have announced their belief that it is superior to uretero-intestinal anastomosis. Some believe it is almost impossible to apply the drainage tubes and other postoperative apparatus necessary in the former procedure so that no leakage of urine takes place. Keshi considers uretero-enterostomy the best method. The three Coffey technics or modifications of them are most commonly used at the present time.

Keshi concludes that the greatest obstacle to radical surgery for the cure of cancer of the bladder is a lack of safe and satisfactory methods of urine disposal; that cutaneous ureterostomy is probably the safest method available at this time and that uretero-intestinal anastomosis provides the best functional results.

Figure 1096 depicts the two-stage ureteral transplantation.

Diverticulectomy

Historical Notes. Various methods of treating vesical diverticulae have been devised from time to time. Pousson advocated closure of the orifice of the diverticulum by suture. Alexander suggested ligature and excision of the sac.

A. If the diverticulum is on the anterior surface or side of the bladder, make a transverse or median abdominal incision. Do not open the peritoneum. Push it aside until the diverticulum is exposed. Excise the diverticulum and treat the bladder wound by appropriate suturing.

B. If the diverticulum is on the dome of the bladder and cannot be exposed extraperitoneally, open the abdomen, protect the peritoneal cavity with pads and excise the diverticulum. Close the wound and drain.

Since a diverticulum may be a source of infection the operation may be done in two stages:

Stage 1. Bring the diverticulum and part of the vesical wall into the abdominal wound and suture the parietal peritoneum to the bladder around the diverticulum.

Stage 2. After adhesions protect the peritoneum, excise the diverticulum and close the vesical wound.

[1] J.A.M.A., Sept. 21, 1929.

C. If the diverticulum arises from the posterior wall of the bladder and lies between the bladder and rectum, Gramer suggests the following operation:

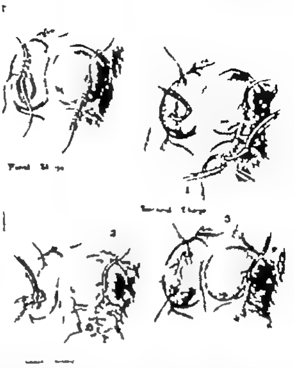


Fig. 1096. Two stage ureteral transplantation. In the first stage the ureters are mobilized and implanted under the mesentery of sigmoid. In the second stage (2 and 3) the ureters are cut distal to the implanted area and inserted in the lumen of the bowel through a [illegible] which is later closed with a purse-string suture. (Courtesy of Dr. Earl M. Keshi.)

Gramer's Operation

Step 1. Drain and explore the bladder suprapubically. With a sound in the diverticulum and a finger in the rectum ascertain and define the size and location of the diverticulum.

Step 2. Place the patient in the combined Trendelenburg and lithotomy position. Make a curved transverse incision from one ischial tuberosity to the

other. Using a sound as a guide, expose the membranous urethra and the prostate.

Step 3. Separate the rectum from the prostate and bladder until the diverticulum is reached. This is fastened firmly to its surroundings. Remove the finger from the rectum and change gloves.

Step 4. Open the diverticulum. Insert a finger; separate the diverticulum from its surroundings by blunt and sharp dissection; push the peritoneum out of the way.

Step 5. Excise the diverticulum and invert its stump into the bladder by means of sutures, being careful not to injure or include the ureter.

Step 6. Drain the perineal wound. Provide for suprapubic drainage.

OPERATIONS FOR EXSTROPHY OF THE BLADDER

(Ectopia Vesicae)

W. Thomas Walker summarized the operations which have been formulated for the relief of exstrophy of the bladder as follows:

- Formation of a reservoir in the body.
  - A. From the bladder.
    - Closure of the defect by autoplastic operation.
      - a. Of skin.
      - b. Of intestine.
    - Closure of the defect by flaps.
  - B. From the rectum.
    - By transplantation of the ureters.
    - By uniocernal fistula.
  - C. From the sigmoid flexure.
  - D. From the vagina.
- No reservoir formed in the body.
  - A. Implantation of ureters.
    - Into the urethra.
    - Into the skin.
  - B. Nephrectomy.

Historical Notes. Simon transplanted the ureters into the rectum, in 1851, for the purpose of diverting the urine into the intestinal tract. In 1852 Roux constructed by a plastic procedure a bladder of the abdominal wall. In 1854 Nélaton modified Roux's procedure. Both these attempts were unsuccessful. Ayres and Pancoast, American surgeons, were, according to Hutchins, first to report successful attempts at plastic operations for the relief of this condition in 1859. Trendelenburg, in 1885, proposed a technic which consisted of a sacro-iliac arthrotomy on one or both sides followed by placing the affected child in an apparatus which was intended to approximate the pubic bones. The patient was obliged to remain in this for three or four months. The second stage of the operation consisted of a [illegible] and suture of the bladder and closure of the anterior abdominal wall. A special compressor was devised by Wilms which brought the bones together without injury to the soft parts. Lagos, as antagonist to the Trendelenburg operation, stated that "this operation not only does not give control, but in many instances the others, and has not justified the hopes upon which it was based." Hutchins found a review of the literature, declares that the only way to eliminate incontinence is by transplantation of the ureters into

[1] Coraál. J. Chir., [illegible], 1889.
[2] Ann. Surg., 1905, XLV, [illegible].

the intestine either intra- or extraperitoneally. Among those who have contributed to the surgical treatment of ectopia vesicae must be mentioned the Mayos, Moynihan, the Hutchins brothers, Burns, Maydl and others. (Fig. 1097.)

Remarks. The principal objection to most operations for reconstruction of the bladder is that the final result is merely the formation of a urinary receptacle bereft of any sphincter; hence incontinence results. The best that is accomplished is to avoid irritation to the exposed vesical mucosa and to direct the urine to the penile gutter where a portable urinal may more readily be attached. It must be remembered that in plastic reconstruction of the bladder the operation often results in fistulas. Uretero-sigmoidostomy or ureterocolostomy invariably

Fig. 1097. Exstrophy of the bladder.

results in ascending infections via the ureters. Maydl's operation of transplanting the ureters together with their sphincteric attachments to the wall of the bladder seems to avoid such ascending infections from the bowel toward the upper urinary apparatus. It is, therefore, considered by many the operation of choice. The lower bowel soon becomes tolerant to the influx of the diverted urine and the sphincters of the lower intestine effectively prevent the escape of urine.

Maydl's Operation[1]

Object. Transplantation of the trigone of the bladder together with the ureteral openings into the sigmoid flexure of the colon.

Step 1. (Fig. 1098 a.) Catheterize each ureter. Incise the abdominal wall at the junction of the mucous membrane of the exstrophied bladder with the skin beginning at the margin of the defect. Two fingers introduced into the peritoneal cavity act as a guide. The incision is carried clear around the circumference of the bladder to the edge of the urethral gutter. If one

[1] Wien. Med. Woch., 1894.
Hutchins, Ann. of Surg., 1902, XLII, [illegible].
Bernard Lowe, Ann. of Surg., 1902.

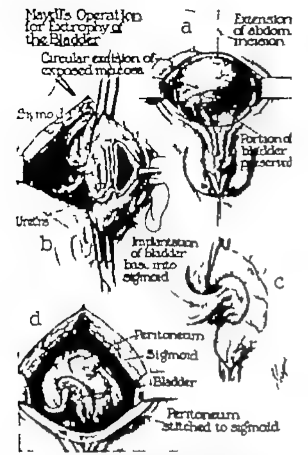


FIG. [illegible]. Mayo's operation for exstrophy of the bladder. [illegible] The peritoneal opening closed by suturing to the sigmoid.

of the ureters opens near the skin [illegible] portion of the skin is to be removed with it.

Step 2. Divide the urethra across immediately above the ejaculatory ducts. Separate the ureters carefully at the lower part of their pelvic course. It is understood that during this step of the operation the blood supply of the ureters must not be interfered with.

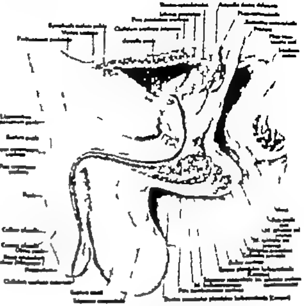


FIG. [illegible]. Median section through the pelvic organs in the male; right half, viewed from the left side [illegible] (After W. Braune.)

Step 3. Cut away the bladder wall leaving an oval area in which the ureters open. Around this oval there should be a rather wide margin of [illegible] overlapping the musculature of the bladder.

Step 4. Extend the abdominal incision upward in the median line. Deliver the sigmoid flexure of the colon (Fig. [illegible] b). Empty the bowel by stripping it of its contents. Clamp the portion of bowel into which the implantation is to be done with intestinal clamps. Make a longitudinal incision along the free border of the bowel. Hold the lips of the wound apart with traction sutures. Fit the bladder wall and the ureters into the opening made in the

intestine by bringing them into proper position. With through and through catgut or linen sutures the edges of the portion of the bladder wall attached to the ureters are sutured to the edges of the wound in the sigmoid. Superimpose this line of sutures by a line of continuous Lembert sutures. Thus, the normal ureteral valves or sphincters are retained preventing ascending infections (Fig. [illegible] c, d).

Step 5. Peritonealize thoroughly. Close the abdominal wound.

OPERATIONS ON THE PROSTATE GLAND AND SEMINAL VESICLES

Anatomic Considerations. (Figs. [illegible].) The normal prostate is [illegible] in shape [illegible]. It has a base, an apex, a posterior and two lateral surfaces. It is traversed from base to apex by the prostatic part of the urethra and encloses in its upper part the ejaculatory ducts. The apex rests upon the [illegible] layer of the triangular ligament (urogenital diaphragm). The posterior surface rests upon the anterior wall of the rectum. In its upper part there [illegible]

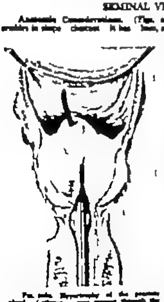


FIG. [illegible]. [illegible]

[illegible]

The Blood Vessels of the Prostate. Arteries. Branches of the inferior vesical and middle hemorrhoidal. [illegible]

Veins. [illegible]

The lymph channels [illegible]

The sensory nerves of the prostate gland are derived from the [illegible]

[illegible]

The Seminal Vesicles. These are located at the base of the bladder obliquely [illegible]

Historical Notes. [illegible]

PERINEAL PROSTATECTOMY

Proust' and Albarran' Operation

The patient is placed on the operating table in the position described as inverted perineal (Position perineale inversée of Proust). After the bladder has been washed out, a staff is inserted. The legs of the patient are held in vertical position and the thighs horizontally by a metal framework fastened to the operating table. Elevate the buttocks so that the perineum is directed toward the ceiling of the room and the sacrum is almost vertical. An assistant holds the staff so that it lifts the urethra toward the pubic arch, precluding its being severed while the preliminary dissection of the perineum takes place.

Step 1. Make a curved incision with its convexity forward, about the width of two fingers from the anus, across the perineum to the ischium including the skin and subcutaneous tissues (Fig. [illegible] a). The external anal sphincter posteriorly and the bulb covered by the bulbocavernosus muscles anteriorly are exposed. Divide the [illegible] raphé. Draw the bulb forward by means of forceps, exposing the posterior border of the transverse perineal muscles in view (Fig. [illegible] b).

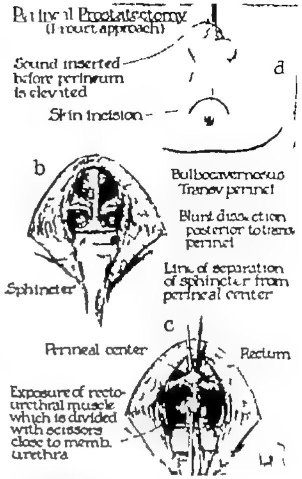
Step 2. While the bulb is drawn forward the posterior lip of the incision is drawn backward exposing the recto-urethral muscles. Push the levatores ani aside with the fingers and divide the recto-urethral muscles close to the transverse ligament. The rectum then drops back and the apex of the prostate is brought into view. Push back the surrounding tissues with the fingers and further expose the prostate. If the incisions are correctly made there should be little bleeding (Fig. [illegible] c).

Step 3. Insert a broad duck-bill retractor in the posterior part of the incision and draw the rectum backward (Fig. [illegible] d). Open the urethra on the staff at the apex of the prostate. Proust emphasizes opening the prostatic rather than the membranous urethra. [illegible] the margins of the mucous membrane with forceps or [illegible]. Introduce a depressor, the arms of which are fixed about the neck of the bladder. The assistant takes charge of this instrument and by means of it pushes the prostate through the wound (Fig. [illegible] e). Apply two strong catch forceps to the prostatic sheath, one on each side of the urethra and peel the sheath from the prostate by means of scissors and blunt dissection.

Step 4. Enlarge the urethral aperture posteriorly as far as the neck of the bladder which should not be punctured, and bisect the prostate. Using the forefinger of the left hand as a guide, separate each lobe from the urethra with scissors, blunt dissection and the forefinger of the right hand; sufficient prostatic tissue should be left as a support for the urethra (Fig. [illegible] f). During this procedure the lobes are brought to the surface by means of catch forceps and depressed by means of the tractor. When pedunculated outgrowths of the prostate in the bladder are encountered they are pushed or hooked through the urethral wound with the finger and are either cut off with scissors or torn away.

Step 5. Clip off redundant portions of the urethra leaving sufficient membrane

[illegible]



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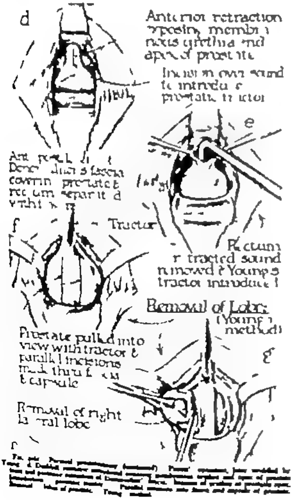
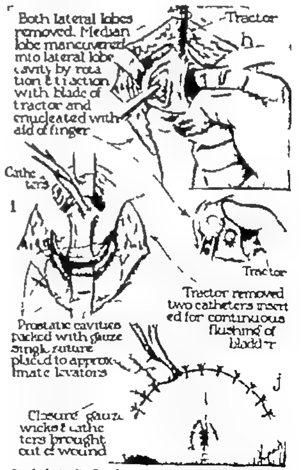


[illegible]



[illegible]

to cover staff inserted through the urethra. Bring the edges of the urethra together with several catgut sutures, beginning at the vesical extremity of the wound, leaving enough space in front to insert drainage tube into the bladder after the staff is withdrawn. Introduce catheter into the bladder through the penis. This is for the purpose of irrigating the bladder and not for carrying off the urine which flows through the perineal tube. Bring together the levatores ani and adjoining structures by means of one or two deep catgut sutures. Place gauze drains in the perineal wound while the posterior skin flap is held in place by sutures on each side, leaving the central part open through which the gauze emerges. Dressings are held in place with broad T-bandage, pressure being applied between the coccyx and the penis thus bringing the bladder and urethra in apposition with the rectum in the deeper parts of the incision.

A perineal tube conducts the urine to receptacle under the bed. Irrigate the bladder twice day and change the dressings daily after the second day. Remove the perineal tube after week. The catheter is changed and cleansed from time to time but is not removed until the perineal wound is completely closed (usually three to five weeks) after which the urine is allowed to pass through the penis.

Albarran's Modification. This consists of removing the lobes by morcellation instead of in toto. Proust admits there are cases, especially where the prostate is friable, where this procedure is preferable.

YOUNG'S MODIFICATION OF PROUST AND ALBARRAN'S OPERATION (1903)

Young follows Proust and Albarran's procedure quite closely with the following modifications (Fig. 2061 g, h, i, j):

(a) The perineal incision is inverted, V-shaped.
(b) The membranous urethra is opened so that tractor may be inserted, and later on drain; an effort is made to keep the prostatic urethra intact while removing the prostate.
(c) A central wedge of the prostate is left so as to preserve the ejaculatory ducts. On this account, after exposing the posterior surface of the prostate, make an incision on each side of the midline for almost the whole length of the posterior surface of the prostate about 3 cm deep. The lines diverge, being about 1 cm. apart posteriorly and 3 cm apart anteriorly. The ejaculatory ducts lie in the tissue between them, thus rendering the preservation of this strip of tissue important if these ducts are to be left uninjured.
(d) A double catheter placed in the bladder through the membranous urethral wound and secured by suture permitting continuous irrigation. This is left in place for 24 hours after which the urine flows through the perineal wound until it heals by granulation.
(e) Pack the lateral cavities with gauze. Remove the packing after 24 hours no further packing is done.

SUPRAPUBIC PROSTATECTOMY

(McGill, Belfield, 1887; Fuller, 1894; Freyer, 1900)

The majority of surgeons prefer this to the perineal procedure. The operation is performed in two stages:

(A) Suprapubic Cystotomy
(B) Transvesical Enucleation of the Prostate

(A) Suprapubic Cystotomy

(B) Transvesical Enucleation of the Prostate

Step 1. Spinal or nitrous oxide-oxygen anesthesia; local infiltration anesthesia may be used to advantage. Trendelenburg posture. Preparation of the field of operation. Catheterize the bladder. Wash it out with any antiseptic solution leaving some solution in the bladder. The catheter left in the

Step 2. The incision in the bladder is usually short, about ½ inches if only finger enucleation unaided by the eye is contemplated. If complete exposure is desired so that the operation carried out under the surveillance of the eye, large opening is essential.

Enucleation of the prostate without ocular guidance. Introduce the index finger of the left hand into the rectum; push the prostate upward and forward (Fig. 2062). The forefinger of the right hand is introduced through the suprapubic opening. With the finger nail make tear in the mucous membrane covering the most prominent intravesical portion of the prostate. The enucleation is begun externally; the mucous membrane covering the lobe of the prostate is pushed away and with it the vesical neck. The finger works its way between the mucous membrane and the prostatic substance hugging the latter closely. Reaching the anterior surface of the prostate, the prostatic lobes are separated from the mucous membrane of the urethra as completely as possible. The adhesions at the apex of the gland are broken through. The capsule is then separated from the prostatic sheath. The finger is then swept in circular fashion from without inward, in front of and to the inner side of the lobe detaching it from the urethra which is left covering the catheter. The other lobe is treated in similar fashion. With downward pressure, the finger passes immediately behind the posterior surface of the median lobe or commissure and above the ejaculatory ducts. The urethra usually breaks off at the triangular ligament, short distance above the "cock's comb" (veru montanum). The opposite enlargement undergoes the same digital manipulation. Vigorous upward pressure by the finger in the rectum is of great aid to the enucleating finger in the bladder and when totally freed the prostate is pushed by the finger in the rectum into the bladder, whence it extracted with pair of strong forceps, through the suprapubic wound. Occasionally the lobes become detached along both anterior and posterior commissures and come away separately. A strong compression forceps properly used will much reduce the size of the freed gland so that may be delivered with greater facility.

Step 3. There is no advantage to be gained, some authors argue (Freyer), by leaving the vesical end of the urethra behind. The finger in the rectum pushes up the prostatic bed while the finger in the bladder compresses the intervening tissues on top of for short period. Massage, thus carried out, diminishes the size of the prostatic bed bleeding ceases. The procedure may be likened to uterine massage or the kneading of the gum by the

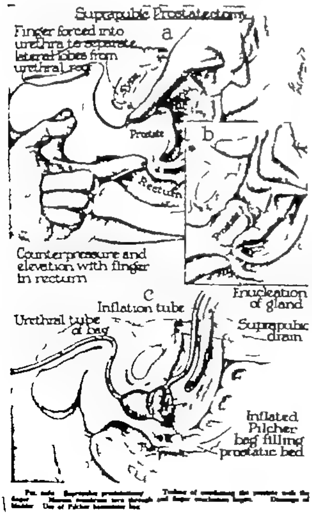


Fig. 2062. Suprapubic prostatectomy. Technic of enucleating the prostate with the finger. Mucous membrane torn through and finger enucleation begun. Drainage of bladder. Use of Pilcher hemostatic bag.

dentist. Irrigate the bladder through the catheter still in situ with hot boric acid solution at about 110 F. This irrigation must be short (one or two minutes). If prolonged it too long encourages bleeding instead of arresting it. Introduce large drainage tube into the suprapubic wound (Fig. 2062 c). The management of this tube in the postoperative care is regarded as of utmost importance. The size of the tube is of importance. Freyer states, "I now invariably employ ¾ inch tubing with lumen of ½ inch in diameter. Two large fenestrae are made near the vesical end of the tube. It of importance that only about an inch or so projects into the bladder. If permitted to project into the bed of the prostate its contraction is retarded and much annoyance is experienced by the patient (pain radiating to the penis, vesical tenesmus, etc.). Bring the edges of the wound around the tube (a large de Pezzer may be used to advantage). Close the abdominal wall with as few silkworm-gut sutures as possible. Use no buried sutures! they are sure to become infected. One of the sutures should transfix the tube.

Step 4. Remove the urethral catheter. Pack or use Pilcher bag if necessary. Douse the space of Retzius. Drain the wound with voluminous dressings.

J. E. Cannaday's Technic of Suprapubic Prostatectomy

Historical Notes. This technic is based, in part, on the early work of Dr. Marsh of Sydney, Australia, Lower of Cleveland and Hall of Charlottesville. Suture of the floor of the bladder for control of hemorrhage was probably first carried out by Deaver. He sutured the bladder mucosa over gauze pack. Later, Judd obtained hemostatic control by placing interrupted sutures around the torn edges of the bladder mucosa, and thereby was able to control bleeding subsequent to prostatectomy. Both Lower and Harris carried out plastic reconstruction procedures on the floor of the bladder. Cannaday's method differs to some extent from that of the others in that the indwelling catheter first placed in the urethra, after which the reconstruction made around the catheter. The edges of the bladder mucosa are brought together in such manner that practically all of the raw surface is covered.

Stage I

Step 1. Make transverse incision down through the skin and fat to the bladder wall. Do not enter the perivesical space.

Step 2. Pack the wound with vaseline-gauze (Bill). Leave the gauze pack in place from eight to ten days. (In some cases Cannaday sutured the skin over the gauze packing.) This builds up defensive wall that will protect the perivesical space from subsequent infection. Introduce an indwelling catheter wherever it is advisable to have suprapubic drainage instituted.

Stage II

Step 1. About two weeks later after the patient has become properly stabilized, especially with reference to blood and urine chemistry, the prostate is enucleated through suprapubic incision mainly by digital dissection (Figs. 2063-2064).

Step 2. Introduce an indwelling urethral catheter into the bladder (Fig. 2065).

Step 3. Reconstruct the floor of the bladder along the lines suggested by Lower (Fig. 2066). Transfix the tip or eye end of the catheter with non-absorbable suture (linen or silk). Bring this suture out through the fundus of

FIG. [illegible]. Digital enucleation of hypertrophied prostate

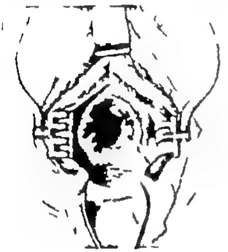


FIG. [illegible]. Bed of prostate after digital enucleation. (Courtesy, Dr. J. E. Cannaday.)

the bladder and secure it over a button or piece of rubber tubing so as to prevent the catheter from slipping out of the bladder (Figs. [illegible]).

Step 4. Secure perfect hemostasis by meticulous reconstruction of the floor of the bladder with interrupted catgut sutures carried on an offset or boomerang type of needleholder. Where reason exists to doubt that hemostasis is perfect, the fundus of the bladder is left open; otherwise it is closed.

Step 5. Close the abdominal wound partially.

FIG. [illegible]. Introducing indwelling catheter. (Courtesy, Dr. J. E. Cannaday.)

Comment. Leave the indwelling catheter in the bladder as long as feasible (usually about [illegible] week). Cannaday states that many patients thus operated on were able to void naturally two or three days after removal of the indwelling catheter.

Squier's Intraurethral Method

With the index finger in the prostatic urethra, the point of least resistance in the urethra is sought, which usually is on the lateral walls, where division between the prostate and urethra is accomplished with ease. After the finger has found its way to the proper line of cleavage, it sweeps first slowly around the distal portion of the adenoma, and then upward over the anterior surface of the tissue separating it from the prevesical space. The finger then glides over the urethra to the other side and the opposite lobe is freed similarly. The operating

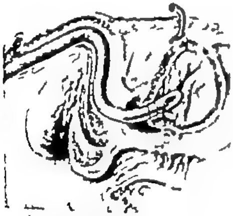


FIG. [illegible]. Reconstruction of the floor of the bladder.

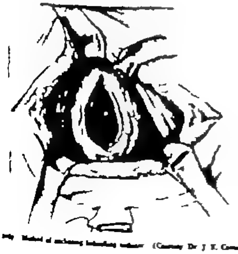


FIG. [illegible]. Method of anchoring indwelling catheter. (Courtesy, Dr. J. E. Cannaday.)

finger then pushes the loosened adenoma into the bladder after detaching it in all directions and from the urethra.

Comment. Following the removal of the prostate, all foreign material should be removed from the bladder (blood clots, portions of prostatic tissue, calculi).

Control of hemorrhage is effected by:

( ) Natural contractions of the prostatic bed.
(b) Massage of the prostatic cavity as detailed above.
(c) Bag hemostasis—the inflatable bag of Hagner or Pilcher hemostatic bag.

FIG. [illegible]. Method of fixing indwelling catheter in prostatic bed and skin. (Courtesy, Dr. J. E. Cannaday.)

Suprapubic Prostatectomy Under Visual Guidance

(Thomson Walker, Judd, Hunt)

In cases where firm, fibrous adhesions prevent enucleation of the prostate as described above, the patient is put in full Trendelenburg position, the prostatic bed is exposed, bleeding vessels caught and ligated, tags of mucous membrane are trimmed away and in difficult cases, the mucous membrane about the adenomatous mass, incised by the scissors under adequate exposure and illumination.

ELECTROSURGICAL RESECTION OF THE PROSTATE*

Perineal Resection (McCarthy Operation)

Step 1. Put a lead belt around the patient's waist. Connect it to one terminal of the diathermy apparatus. A pad is inserted between the buckle and skin to prevent sparking.

Step 2. Inject 10 cc. of coagulen (Ciba) into one buttock. Paint the external genitals with [illegible] per cent picric acid solution and isolate them with sterile towels.

Step 3. Screw the operating table to its highest position. Lubricate the sheath of the electrotome and with its obturator in position, pass it gently down the urethra. If any obstruction is encountered at the neck of the bladder withdraw the instrument. Dilate the obstruction with graduated sounds up to degree which will permit the electrotome to pass (Figs. [illegible]).

Step 4. Remove the obturator.

* See also "Operations for Obstruction of the [illegible] Vesicae," p. [illegible]

Step 5. Allow residual urine to escape. Wash out the bladder with sterile water until the return flow is entirely clear.

Step 6. Attach the cords from the battery to the telescope of the loop-electrode carrier and test the light.

Step 7. Insert the carrier with attached loop into the sheath. Connect the inflow cock on the sheath to the irrigating stand and attach a piece of rubber tubing to the outflow cock which is permitted to hang in a floor receptacle.

Step 8. Attach the cable from the diathermy apparatus to the electrotome. Examine the prostate thoroughly. Orientation as to the position of the

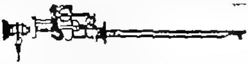


Fig. 2069. McCarthy visual prostatic electrotome (assembled).

median lobe or prostatic bar is essential. Withdrawal of the instrument into the posterior urethra gives one an estimate as to the extent of the intravesical enlargement of the obstructing prostate.

Step 9. Locate and inspect the veru montanum and the sinus pocularis into which the two ejaculatory ducts open. The topographic anatomy is of vital importance and the landmarks mentioned must be avoided from inclusion by the electrocutting loop.

Step 10. Empty the bladder. Open the inflow cock. Advance the cutting loop. Hook it over the edge of the prostatic neck.

Step 11. Elevate the ocular end of the instrument allowing the loop to engage the enlarged, projecting portion of the prostate (Figs. 2071-2073).

Fig. 2070. McCarthy visual prostatic electrotome (assembled).

Step 12. Turn the current dial on setting No. 5. Wait a moment until the loop heats up. Drag the loop slowly forward through the large median lobe by rotating the pinion handle of the instrument. During the second half of the cut the small lever on the pinion block forces the telescope back by engaging with its pin. When the cut is completed, close the inlet cock, turn off the current and remove the electrode carrier from its sheath (Fig. 2073). This will permit the bladder to empty itself. The cut is about an inch long and it should take about 10 seconds to perform. At no time should force be applied to the pinion handle. If this precaution is not heeded the loop is

Fig. 2071. First cutting step. Instrument with loop in position. (Courtesy of Dr. J. F. McCarthy: Penn. Med. Jour.)

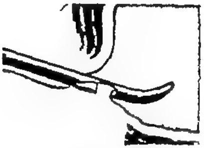


Fig. 2072. Tissue partly resected. (Courtesy of Dr. J. F. McCarthy: Penn. Med. Jour.)

Fig. 2073. First step in cutting completed. (Courtesy of Dr. J. F. McCarthy: Penn. Med. Jour.)

liable to break or bend, causing bleeding. As a rule, the excised portion of the prostate adheres to the cutting loop and is removed by forceps. Before inserting the loop electrode carrier to perform the second cut, the small lever on the pinion block which has been forcing the telescope back is raised and the latter pushed home. This is repeated from 10 to 20 times, the object being to lower the floor of the posterior urethra leveled as far as possible to one straight line. Be sure that while cutting, the water flows into the bladder distending it partially at the beginning of the incision, thus preventing burning the mucous membrane or perforating its wall. Bubbles which result from the cutting process obscuring the view can generally be dislodged by rotating the instrument. J. C. Aynsworth Davis points out that any vessels may be ignored into water is running into the bladder.

Step 13. When through, withdraw the electrode carrier from the sheath and replace by bugbee electrode.

Step 14. Survey the field for any bleeding vessels in the prostatic urethra and if any are found secure hemostasis by coagulation.

Comment. Two rapid resection encourages hemorrhage. Hemostasis must be perfect. Ragged edges must be destroyed with the electrode and any portions of prostate searched for and removed. The flow of the irrigating fluid must be rapid. McCarthy employs two telescope attachments ready for immediate use. When resection of the floor is completed, one lateral lobe is attacked and then the other. McCarthy leaves an indwelling catheter from two to four days. The operation may be completed in one or more stages. He points out the occurrence of ascending cystitis which may result in pyelonephritis and he stresses the limitations of the operation. Only an experienced surgeon should undertake this operation. Bransford Lewis admonishes against excessive optimism with this operation. A recent annual entitled "Prostatic Resection Without the Moonlight and Roses"[1] that is ably discussed by Lewis.

SUPRAPUBIC RESECTION

J. C. Aynsworth Davis Method

By this method, the prostatic tissues to be removed are made visible and the entire operation is carried out under ocular guidance.

Step 1. Place a lead plate covered with gauze soaked in salt solution under the patient's buttocks and connect the plate to one terminal of the diathermy machine, inserting a pad between the buckle and the skin to prevent sparking.

Step 2. Inject 10 cc. of cocaine (Clin) into the buttock of the patient and paint the buttocks with 3 per cent. picric acid solution. The preparation should include the skin, lower abdomen and external genitals. The front and inner aspects of the thighs should also be included, particular attention being paid to the pubic parts.

Step 3. Pass a catheter. Wash out the bladder and do a suprapubic cystotomy.

Step 4. Place the patient in the Trendelenburg position. Insert a self-retaining bladder retractor. Inspect the prostate.

Step 5. From the intravesical projection of the median lobe or posterior margin

[1] ... and Cut. Review, Jan., 1933.

of a fibrous prostate with a pair of special prostatic forceps. Pass the enlargement through the cutting loop and withdraw as far as possible into the cavity of the bladder in the manner of engaging a tonsil in a snare.

Step 6. Excise the seized portion of the prostate by means of the cutting loop mounted on an insulated handle, connected by an insulated cable to another terminal of the diathermy apparatus. Any spurting vessels are sealed by the prostatic forceps by bringing the diathermy loop in contact with the forceps while switching the current on momentarily. The vessels will promptly be sealed by coagulation. The other portions of the prostate needing removal are treated similarly.

Step 7. When this part of the operation is completed, hemostasis assured and oozing controlled by the button electrode, disconnect the diathermy current. J. C. Aynsworth Davis admonishes that much experience is necessary to gauge the extent of prostate to be removed pointing out that if too little tissue is taken away the obstruction persists and healing of the wound will be either considerably delayed or prevented.

Step 8. Close the bladder around the proper tube as described under cystostomy.

Step 9. Drain the wound.

PROSTATECTOMY FOR CARCINOMA OF THE PROSTATE

The first operation for removal of the prostate for carcinoma was done by Billroth and later by Zuckerkandl. Among French surgeons, Gosset, Proust, Albarran and others; in America, Young, Goodfellow, Watson and others; while in Germany Czerny, Völker and others contributed to the development of the operation.

Young's Radical Operation for Carcinoma of the Prostate[1]

Step 1. Make an inverted U incision with the lateral incisions about an inch longer than is usually practiced. Divide the levator ani muscles slightly on each side.

Step 2. Retract the wound to afford thorough exposure.

Step 3. Insert Young's prostatic tractor into the exposed and incised membranous urethra.

Step 4. Free the rectum carefully from the posterior surface of the prostate and from the seminal vesicles above, care being taken not to penetrate the Denonvilliers fascia anteriorly or to enter the prostate or seminal vesicles covered by it.

Step 5. Free the lateral margins of the prostate by blunt dissection. At this stage of the operation, make a careful inspection to make sure that the carcinoma has not extended beyond operative limits and that at least the upper portions of the seminal vesicles are free from invasion and that no malignant infiltration of the lymph nodes along the pelvic wall on either side has taken place. If in doubt, Young counsels that a frozen section should be made for prompt verification of the diagnosis.

Step 6. Search for a point along the lateral surface of the prostate where the fascia springing from the lateral wall of the pelvis divides to encircle the

[1] H. H. Young: Johns Hopkins Bull., 1905, XVI, 315-321.
——— Ibid: Ann. of Surg., 1905, XLI, 549-557.
——— Ibid: Practice of Urology, 1926.

prostate. Incise the posterior layer close to the prostate and by means of blunt dissection strip the anterior layer from the prostate on either side until the membranous urethra is reached.

Step 7. Make downward traction with the tractor and divide the membranous urethra transversely at a point below the membranous urethrotomy wound.

Step 8. Continue blunt dissection upward. Push away the anterior layer of the fascia and free the prostate until the bladder is reached, immediately above the vesical prostatic juncture in the median line. Plunge a scalpel into the bladder. Enlarge the wound on each side and place a long retractor within the anterior wall of the bladder thus exposing its interior. Identify the trigone of the bladder.

Step 9. Divide the trigone of the bladder by means of a curved incision, the knife passing 1 cm. in front of the urethral orifice on each side and dividing the muscles of the trigone and the bladder wall beneath it.

Step 10. Push the bladder upward by blunt dissection and expose the posterior surface of the seminal vesicles and vasa deferentia.

Step 11. Continue this dissection upward until the tip of the seminal vesicle is reached and its ampulla is isolated.

Step 12. Pick up the respective vas deferens with a hook. Divide the fibrous attachment of the upper portion of the seminal vesicle. Clamp these and ligate them carefully in order to avoid bleeding.

Step 13. Clamp the vasa deferentia, divide them and remove en bloc the entire prostate with its capsule with the fixed cuff of the bladder and both seminal vesicles and ampullae. Inspect and make sure that the entire tumor has been removed. If portions of suspicious tissue remain, Young counsels the introduction of radium.

Step 14. The large open wound of the bladder must now be anastomosed with the membranous urethra. This is accomplished by pulling down the anterior part of the bladder wall and joining it with the stump of the membranous urethra by means of heavy chromic catgut sutures so that the sutures include the mucous membrane and the ligature knots are placed externally. About eight to ten sutures are sufficient to accomplish this anastomosis. Young admonishes that the sutures should be placed deeply through adjacent muscle structures, and not tied too tightly. A catheter projects into the bladder during this procedure and it is left in place for drainage.

Step 15. Close the remainder of the bladder posteriorly by continuous chromic catgut sutures not including the mucous membrane.

Step 16. See that hemostasis is perfect. In one of Young's cases a blood vessel retracted, giving rise to retroperitoneal hemorrhage.

Step 17. Unite the levator ani muscles with chromic catgut sutures. Close the wound without drainage. Fasten the indwelling catheter to the penis with adhesive plaster.

PROSTATOTOMY

Operation for Prostatic Abscess

Place the patient in an exaggerated perineal position. Both lobes of the prostate are usually explored to make sure that a suppurative focus in one of the lobes does not escape detection.

Step 1. Shave and prepare the perineum. Anesthetize the patient and place him in the lithotomy position.

Step 2. Introduce the index finger of the left hand into the rectum; explore for points of fluctuation.

Step 3. Introduce the point of a sharp-pointed long scalpel through the median raphé of the perineum about an inch in front of the anus, directing it with firm pressure toward the finger in the rectum (Fig. [illegible]). Enlarge the external incision as the knife is withdrawn.

Step 4. Introduce a closed curved clamp into the abscess cavity and withdraw it with jaws open.

Step 5. Discard the infected glove of the left hand. Don a fresh one.

Step 6. Introduce the finger into the abscess cavity; explore; break down septae and accessory collections of pus.

Step 7. Introduce a large drainage tube into the abscess cavity; fix it to the skin with suture. Irrigate the abscess cavity.

Fig. [illegible]. Dotted line indicates position of rupture; incision for prostatic abscess shown outlined by vertical line.

Comment. When bleeding is profuse pack with iodoform gauze. If during these manipulations the urethra has been opened, introduce a catheter into the bladder through the urethral opening and encourage drainage for a few days.

The rectum or bladder may be opened during the operation; if so, repair the injured viscus at once. John Cunningham, Jr. opened the rectum six times, the bladder three times and the peritoneum three times in over four hundred operations. The end-results were satisfactory after prompt repair of the injury.

The less expert will do best to abstain from extensive dissections in this area and be satisfied with a less radical undertaking. In early cases conservative measures may suffice. Often prostatic abscesses burst into the urethra.

OPERATIONS FOR OBSTRUCTIONS OF THE TRIGONUM VESICAE*

Historical Notes. Vesical obstruction caused by median bar hypertrophy was first described by Guthrie in 1830. Bottini of Pavia introduced the operation of division of the prostatic bar or outgrowth by means of the galvanocautery. An electrode shaped somewhat like a Mercier catheter is introduced into the bladder through the urethra. The beak of the instrument is turned around and the instrument pulled forward until it impinges against the obstruction. The current is then turned on and the obstructing portion of tissue is burned through. This procedure is known as the operation of Bottini and Chetwood and was done either transurethrally or by the perineal route—perineal galvanoprostatotomy (Chetwood).

Also Randall in 1917 contributed his observations of post-mortem studies of this condition. Notable progress was made through the cystoscopic studies of Randall, Young, Caulk, Warren and others of our time. A. R. Stevens (1913), Collings and Taylor, McCarthy, Stern, Lyon and Bruce Roper perfected instruments and set down

* See also "Transurethral Resection of the Prostate," [illegible].

indications and data for the proper and timely performance of this operation in such conditions as enlarged median bar, contracture at the vesical neck, and small nonfibroid fibrous and muscular hypertrophy without hypertrophy of the median lobe. Joseph F. McCarthy, De K. Ross, Collings, Foley, Day, Bumpus and Bumpus have done much to popularize electrosurgical resection of the prostatic obstruction lesions.

Step 1. Anesthetize the urethra. Young advises the use of 4 per cent procaine in the bladder and deep urethra. Infiltration of the neck of the bladder by means of a special needle is counseled by Caulk. Zuckerkandl and Rubritius prefer caudal anesthesia.

Step 2. Introduce the sheath together with the obturator of the instrument into the bladder.

Step 3. Withdraw the obturator and evacuate the urine.

Step 4. Pull the instrument forward until the vesical orifice engages in the slot or fenestrum when the instrument is pressed firmly downward and is simultaneously drawn forward.

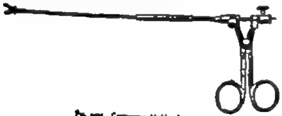


Fig. [illegible]. Cystoscopic bladder forceps.

Step 5. Introduce now the cautery blade through the sheath of the instrument until it engages the obstruction.

Step 6. Turn on the current, push the inner tube home, cutting away the tissue within the slot or fenestrum.

Step 7. Remove the ablated tissue with a long toothed alligator forceps (Fig. [illegible]).

Comment. Young points out that in order to remove all portions of the prostatic bar both median and lateral incisions are necessary. After completion of the operation, leave a catheter in the bladder for three or four days. Caulk emphasizes that the most important part of the operation is to maintain constantly firm pressure against the orifice in order to squeeze into the slot as much tissue as possible and retain it there. The average time for the action of the current is about four seconds. Do not omit, when removing the instrument, to have the cold cautery blade or obturator in place.

VESICULECTOMY

Hunt's Operation

Step 1. Make an incision in the median line about an inch above the anus to a little above the sacrococcygeal articulation. Carry the incision to the levator ani muscles.

Step 2. Divide the levatores ani in the midline; retract them laterally and expose the rectum.

Step 3. Excise the tip of the coccyx.

Step 4. Mobilize the rectum and displace it laterally, thus exposing the seminal vesicles. They are brought to view immediately after division of the rectovesical fascia.

Step 5. Remove the vesicles together with the vas, if so indicated. If oozing, pack lightly with gauze for forty-eight hours.

Step 6. Drain through a tube or cigarette drain.

Step 7. Suture the divided levatores ani with chromic catgut.

Step 8. Close the skin.

Comment. Operating as outlined is not as technically difficult as with other procedures and obviates injury to the anal sphincters. It is less difficult than the perineal operation (Morrissey and Young's Operation).

OPERATIONS ON THE SCROTUM AND ITS CONTENTS

Vasotomy and Vasectomy

Anesthesia. Infiltration with 1% novocaine.

Vasotomy

Step 1. Grasp the spermatic cord and steady it between the thumb and forefinger.

Step 2. Identify by palpation the vas deferens.

Step 3. Make a small linear incision over the tegumental coverings and deliver the vas by pressing it forward.

Step 4. A blunt-pointed needle, attached to a syringe filled with the fluid one desires to inject into the vas, is thrust into the tubule and the fluid pressed home.

Comment. The two important features of the operation are:

(a) First, to fix the vas so that it does not slip away.

(b) The incision in the vas should only be large enough to permit the insertion of the vasotomy needle. Determine the patency of the lumen of the vas by introducing into its lumen a silkworm-gut strand. Methylene blue was used by the late William T. Belfield; a catheter in the bladder (per urethram) recovers the stained urine if patency of the vas is unimpeded. It is well to insert a silkworm-gut strand under the vas and through the skin and keep the vas closely apposed to the surface for the next twenty-four hours to prevent regurgitation of the fluid. This suture is removed after twenty-four hours. The procedure is nowadays looked upon simply as a test to ascertain the patency of the vas. Such therapeutic operations have been found valueless—hence the procedure has been abandoned as useless for all treatment of disease of the male genital adnexae (Rubritius).

Vasectomy

This procedure is frequently resorted to, preliminary to prostatectomy, to prevent ascending infection and consequent epididymitis. Vasectomy is also used

as a means of male sterilization. The term vasectomy means excision of the entire vas deferens. Partial vasectomy designates the removal of a section of the vas.

PARTIAL VASECTOMY

Step 1. Expose the vas as in the preceding procedure, through an incision in the skin immediately below the external abdominal ring, exposing the cord.
Step 2. Separate the vas from the other structures of the cord and divide it between two ligatures.
Step 3. Resect about half an inch of the vas.
Step 4. The divided, ligated ends are now brought into lateral apposition in such a manner as to *frustrate the possibility of stomal reunion*. This, as has been shown in experiments on lower animals, may occur if not guarded against (Rolnick). Close the wound in the skin.

Anastomosis of the Vas Deferens and Vaso-Epididymostomy

Historical Notes. A lateral anastomosis between the vas deferens and the head of the epididymis was practiced by Martin. The operation was performed entirely extraperitoneally, the suture material was catgut. The technical details and modifications were worked out by Fuller, Hagner, Bogoljuboff, Silva, Quinby, McKenna, Rolnick and others.

Occasions may arise in surgery of the male genital organs where the vas deferens becomes torn, and an end-to-end or other anastomosis is necessary. This appears to have been done first by Parlavecchio, owing to a surgical accident. Some years later Lydston devised a method of cutting the ends off square, then introducing a filament of silkworm-gut on a filiform bougie through an opening in the side and sewing the two square cut ends together. The sheath of the cord was then sewed around the point of the suture and the bougie withdrawn after ten days. Later on Lydston reported that this method was not feasible where the distal end of the vas was atrophied, and that in such case the anastomosis of the proximal end must be made direct to the epididymis.

In Davis' technic the proximal end is cut off obliquely and pointed, the distal end being cut off on a short bevel. A piece of catgut threaded on a fine needle is passed through the tip of the proximal end, then introduced into the lumen of the distal end and made to pierce the wall, well beyond the opening. A second needle on the catgut is similarly brought out near the first. Traction is made on the threads and the pointed extremity of the proximal end enters the lumen of the distal end without trouble until its apex enters the point of emergence of the needles. The catgut is then tied and the apex is fixed in place. The distal end is fixed by a few fine sutures to the side of the proximal end. This operation is a modification of Poggi's ureteral anastomosis.

For "short-circuiting" the vas to the epididymis (especially in cases of male sterility) McKenna cuts down on the vas about two inches above the testicle, incises and exposes the vas, and then [illegible] and anastomoses it with the middle third of the epididymis.

Silva has described a method of intraluminal anastomosis of the vas. Silva's experimental work has been carried out on animals and he claims 90 per cent success. Fig. [illegible] depicts a method of excising a section of the vas deferens with end-to-end anastomosis by means of a strand of silkworm-gut.

EPIDIDYMOVASOTOMY

(F. R. HAGNER'S TECHNIC)

The impetus to this operation has been given by Martin of Philadelphia.

Step 1. General anesthesia. Open the tunica vaginalis testis, expose the entire epididymis. Examine the parts. Ascertain the portion of vas to be anastomosed with the epididymis.
Step [illegible]. Open the vas by a longitudinal incision (Fig. [illegible]). Explore the vas with the finest obtainable tear-duct probe, follow with a smooth strand of silkworm-gut. When the vas is found unobstructed proceed with the operation. Hagner remembers that *if the vas is found obstructed beyond a point 26 to 30 cm. distance toward the vas is not patulous, hence the operation cannot succeed.*

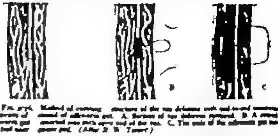


Fig. [illegible]. Method of excising a section of the vas deferens with end-to-end anastomosis by means of a strand of silkworm-gut. A. Section of vas deferens removed. B. A strand of silkworm-gut inserted into both open ends of the vas. C. The ends of the silkworm-gut sutures are tied. (After R. W. Turner.)

Step 3. Cut out an elliptical portion from the epididymis (Fig. [illegible]). Promptly milky fluid will issue which should be examined at once on a warm slide for live, motile spermatozoa. If no spermatozoa are found, close this incision and repeat the procedure at another place.
Step 4. The suture material is selected. Hagner states that fine silver wire was used in most successful cases, when other suture material was used, failures resulted. Hamilton Bailey propounds the question of why this should be so. Hagner states [illegible] cannot explain this unless there is less tissue reaction with silver wire than with other sutures.
Step 5. A lateral anastomosis is made between the opened vas and epididymis (Fig. [illegible]). Cut only into the lumen of the vas, taking care not to inflict injury to the wall opposite the incision. Place the first suture at the distal end of the incision in the vas. Take a substantial bite. Anchor this suture firmly *in the lower end of the elliptical incision in the epididymis.*
Step 6. Place two lateral sutures as shown in Fig. [illegible]. Include some of the tubules in the bite of the needle. Pass this suture through the cut edge of the vas, picking up just sufficient tissue to approximate the edges.
Step 7. Pass the last suture in the same manner through the upper end of the incision in the vas, taking care not to occlude the lumen.

Poggi's Practice of Urology, W. B. Saunders Co., 1926, II, [illegible]

Comment. Hagner reports 63 cases. In this series, eight, or 38 per cent, were cured. The operation may be performed on both sides. If operation fails at the first sitting the procedure may be repeated. Hagner reoperated seven patients because of initial failure. *Three of these were cured.*

HYDROCELE OF THE TUNICA VAGINALIS TESTIS

Historical Notes. There is scarcely a condition for which so many therapeutic suggestions have been offered as for the relief of hydrocele. Internal medications and local applications were much in vogue. Tapping was practiced early. Electricity and electropuncture were much lauded. Injection of irritants was used extensively even up to the present day, although discarded by most surgeons as useless. Among

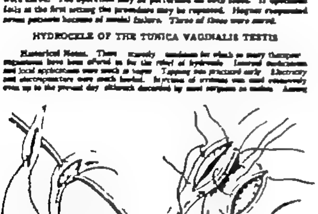


Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Hagner's operation for male sterility. [illegible] step. A fine strand of silkworm-gut or finest tear-duct probe explores the vas deferens to ascertain its patency.

Fig. [illegible]. Hagner's operation for male sterility. [illegible] step. Showing the placement of the sutures of fine silver wire between the opened vas deferens and the head of the epididymis to create a lateral anastomosis between these two structures, thus side-tracking the obstruction in the vas.

the fluids injected into the sac for purposes of obliteration were wine, iodine, tincture of [illegible], zinc chloride, zinc chloride, bichloride of mercury, chloroform, alcohol, ether, silver-nitrate, quinine, etc. Foreign bodies, metal stripes, rubber tubes, silk, catgut, etc.) were advised on the basis that irritation was of only temporary value. Vaccine therapy, McIntosh used B. pyocyaneus or staphylococcus aureus, autoserotherapy, abstraction of hydrocele fluid and reinjecting it into the patient (Bertrich, Gack, Abraham) was used by some to cause resorption and cure of the hydrocele (Caffaro). Hormone-therapy produced no effects. Radical operation has been practiced since the time of Celsus. Volkmann in [illegible] devised an operation which consisted of wide incision of the sac, swabbing the cavity with carbolic acid and suturing the edges of the sac to the skin with catgut. Drainage resulted and obliteration of the sac by granulation ensued. Von Bergmann in [illegible] was first to practice excision of the sac.

The procedures for the relief of hydrocele are either
( ) palliative (tapping) or
(b) radical.

Anatomic Considerations. The relation of the testis to the accumulation of fluid in the tunica vaginalis varies. It is usually behind the hydrocele and occasionally below it. The superimposed structures may glide loosely over the fluid-collection or

be tensely opposed to it, depending upon the degree of fluid distension. The spermatic blood vessels are usually seen coursing through the tissues near the surface of the hydrocele. It is important that the position of the testicle in relation to the hydrocele should be determined before any operative procedure is executed. This is accomplished by transillumination. A hydrocele may be bilocular or even multilocular.

Tapping of a Hydrocele

This simple operation requires a small trocar and cannula, or an aspirating syringe of proper size (Figs. [illegible]).

Step [illegible]. The scrotum to be tapped is properly prepared (shaved and cleansed).
Step [illegible]. Grasp the affected scrotal portion and make it tense with the left hand. Ascertain carefully the position of the testicle and note precisely the course of the scrotal vessels. Avoid these scrupulously during the tapping.

Fig. [illegible]. Marking the veins at the base of the penis. The veins are outlined by means of [illegible] solution blotting the course of the veins [illegible]. For tapping of hydrocele a [illegible] solution [illegible] deposited at the point of puncture of the trocar or the scrotum.

Step 3. Hold the trocar in the right hand and guard it by the index finger to prevent too deep penetration of the instrument. Plunge the trocar quickly upward and backward, into the distended scrotum at about the junction of its middle and lower thirds. By compressing the scrotum the fluid contents are evacuated.
Step 4. Touch the puncture made by the trocar with a dab of iodine.
Step 5. Apply a little collodion and a dressing.

Comment. The trocar may injure the testicle, epididymis or, perchance, a herniated loop of bowel. This may be avoided by exactly locating the field by means of transillumination. The point of the trocar should be sharp, for if, or an ill-fitting cannula, or a lacking thrust may push the thickened tunica vaginalis in front of the instrument. Avoid puncturing of scrotal veins (extravasation, ecchymosis). In old men with large hydroceles, it is advisable to remove the fluid partially, followed later by the removal of the remainder. After complete aspiration of large hydroceles, congestion and hemorrhage have been reported. After tapping, the hydrocele usually refills in from two to six months.

Operations for Hydrocele

SIMPLE EVERSION; ANDREWS' "BOTTLE" OPERATION

Step 1. Open the tunica vaginalis at its upper pole and evacuate its fluid contents.

Fig. [illegible]

Fig. [illegible]

Fig. [illegible]. In [illegible] hydrocele is carried out to bypass the blood vessels of the scrotum. [illegible] shows wrong way of [illegible].

Fig. [illegible]. Puncture of hydrocele. Proper way of introducing trocar between blood vessels.

Fig. [illegible]. Jaboulay operation. Hydrocele. Incision is made over most prominent part of hydrocele. Length of incision [illegible] to illustrate.

Step 2. Bring the testicle outside the scrotum extracting it through the opening in the sac, which is to be only large enough to permit the passage of the testis through it (Figs. [illegible], p. [illegible])

Step 3. Turn the sac simply inside out without suture or, what is much better, pass one or more sutures through the divided edges of the sac, securing them behind the cord to prevent reinversion.

Fig. [illegible]. [illegible] and [illegible] layer of tunica vaginalis [illegible] of scrotum.

Step 4. Reposit the testis and everted tunica vaginalis into the scrotum.
Step 5. Close the wound without drainage.

Comment. The disadvantages of this procedure are that it is not successful in old thickened hydroceles and that recurrences are frequent.

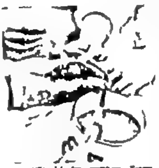


Fig. [illegible]. Jaboulay operation. Evacuation of the hydrocele contents by means of [illegible]

EXCISION AND EVERSION; JABOULAY OPERATION

Excision and eversion of the sac with suture behind the epididymis is the procedure accepted today as the best type of operation in hydrocele. Jaboulay's eversion operation for hydrocele is performed as follows:

Step 1. Open the tunica vaginalis testis by an incision shown in Fig. [illegible].

Step 2. Deliver the testis through this aperture. Excise partially the tunica vaginalis (Figs. [illegible]).

Step 3. Suture the edges of the tunica vaginalis together behind the spermatic cord (Figs. [illegible])

Comment. This turns the sac completely inside out, thereby bringing the secreting surface against connective tissue layer. The method has the advantage that it can be done through a short high incision in which local

Fig. [illegible]. Jaboulay operation. [illegible]

Fig. [illegible]. Jaboulay operation. Placement of first suture uniting the edges of the tunica [illegible]

anesthesia may be advantageously employed. In Jaboulay's operation the smooth endothelial surface of the tunica will be in contact with the raw external connective tissue and will adhere to it.

Fig. [illegible]. Jaboulay operation. Showing placement of sutures.

Fig. [illegible]. Jaboulay

WINKELMANN'S OPERATION

Step 1. Dissect free the [illegible] [illegible].
Step 2. Trim off the sac

Step 3. Take the two cut edges of the parietal stump of tunica with catgut sutures behind the testis. All bleeding points must be secured.

Step 4. Close the wound with (if suspicion of incomplete hemostasis exists) or preferably without drainage.

Step 5. Apply [illegible] dressing.

Comment. Operations for hydrocele may be followed by hemorrhage, atrophy of the testis (rare) and recurrence (1 per cent, H. L. Stanford).

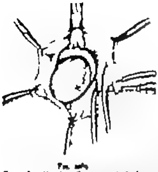


Fig. [illegible]

Fig. [illegible]

Fig. [illegible]. Hamilton Bailey method of excising the tunica vaginalis [illegible] by means of an electric cautery.

Fig. [illegible]. [illegible] the surface of the spermatic cord. [illegible] the cord [illegible] the [illegible] of the [illegible]. [illegible] See also Fig. [illegible], p. [illegible].

HAMILTON BAILEY'S TECHNIC

Hamilton Bailey excises the hydrocele sac by means of the electrocautery. He proceeds as follows:

Step 1. Local anesthesia—[illegible] per cent novocaine along the line of an inguinal incision.

Step 2. Identify the cord and inject it thoroughly with the same solution with hypodermic needle. In order to obviate discomfort during the delivery of the hydrocele the fluid is evacuated by tapping. Particularly is this advisable in cases of large hydroceles.

Step 3. Deliver the testicle onto the surface and open the sac to the extent of its entire length.

Step 4. Ablate the sac by means of the diathermy apparatus or any other form of cautery as near the testicle as possible (Fig. [illegible]).

Step 5. Place additional ligatures over the cauterized stumps whenever it seems desirable. This dual precaution will definitely assure against scrotal hematoma.

OPERATIONS FOR VARICOCELE

Anatomic Considerations. The spermatic vein (and its pampiniform plexus) originates at the posterior border of the testicle as [illegible] thick network of eight or ten veins lying anteriorly and passing upward through the inguinal canal and uniting into one trunk in the abdominal cavity and passing on the right side into the vena cava, on the left into the left renal vein. Besides these there exist under consideration the vas deferens and three arteries. The spermatic artery lies in front and the deferential artery on the side of the vas deferens and the cremasteric artery at the outer side (superficially).

Step 1. Local or general anesthesia, the latter is preferable in anemia. Expose the spermatic cord through a lateral incision in the upper part of the scrotum and extending partly along the inguinal region (Figs. [illegible], p. [illegible], [illegible], p. [illegible]).

Step 2. Deliver the cord; examine the parts thoroughly; expose the enlarged venous bundle; isolate the vas; recognize the spermatic artery.

Step 3. With the fingers separate the large plexus of veins to be excised from the vas and the spermatic artery; leave [illegible] smaller number of veins to carry on the return circulation.

Step 4. Clamp the venous bundle to be excised, above and below. Avoid the spermatic artery.

Step 5. Remove the large veins between the two clamps, to the extent of about two or three inches.

Step 6. Ligate the stumps with catgut and bring them together side by side, thus elevating the testicle.

Step 7. Return the contracted testis and cord into the scrotum.

Step 8. Suture the scrotal structures carefully. Do not drain. Keep the testicle elevated.

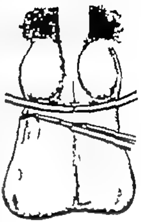


Fig. [illegible]. Resection of scrotum for varicocele. (Horsley.)

Comment. A search for the spermatic artery should always be made and it should, of course, be excluded from the venous bundle to be removed. If the artery is not located, it is well to remember that no prolonged search for the vessel should be made and, while its inclusion in the ligature is undesirable, actual atrophy of the testis rarely occurs. Hemorrhage is the most immediate complication following varicocele operation; this is usually due to imperfect hemostasis during the operation. Large hematomas may require evacuation. An intact deferential artery and veins are usually able to obviate testicular atrophy—they must be scrupulously protected from injury. Hydrocele is usually an annoying postoperative complication. Some surgeons, in order to avoid its occurrence, open the tunica vaginalis. Partial ablation of the scrotum is sometimes indicated (Fig. [illegible]). When in doubt, it is better to excise too little than too much.

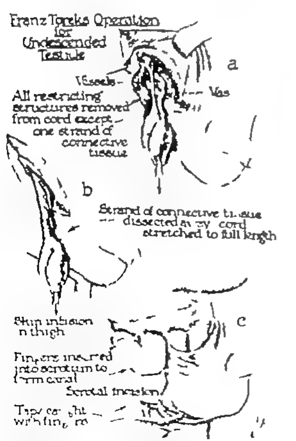


Fig. [illegible]. [illegible] operation for undescended testis. [illegible]

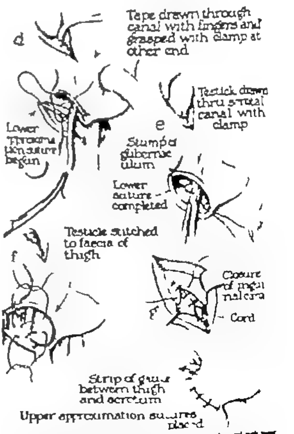


Fig. [illegible] (continued). Torek operation. [illegible] edge of scrotal wound with [illegible] edge of wound in the thigh. [illegible] of testis through scrotal canal. [illegible] Testicle sutured to fascia of the thigh. [illegible] of scrotal wound [illegible] thigh (f) and closure of inguinal canal. [illegible] strip of gauze between thigh and scrotum.

OPERATIONS FOR UNDESCENDED TESTICLE (CRYPTORCHIDISM)

Torek Operation (Orchiopexy)

This consists of laying bare the testicle, thinning down the cord till it consists of nothing but vas deferens and spermatic vessels, and continuing the dissection of the vessels upward as far as necessary to allow the testicle to come well down without traction. After bringing the testicle out through an incision at the bottom of the scrotum and carrying it through a corresponding incision in the skin of the thigh, it is fastened to the fascia of the thigh, and the rudimentary scrotum is fastened to the skin of the thigh. After a couple of months the testicle is released and replaced in the scrotum.

Step 1. Make an incision as in the operation for inguinal hernia. The exposure of the inguinal canal must be ample and large enough to permit of extensive dissection of the cord without injury to the spermatic vessels.

Step 2. The testicle must be freely liberated. It must be freed from tubular tissues, cremaster muscle and gubernaculum testis. The same holds true of the spermatic cord of which only the vas deferens and the spermatic vessels are preserved intact—all other tissues are removed including the vaginal process. If a congenital hernia is present, it is located in the vaginal process. If that process is obliterated, it is removed and its stump allowed to retract. Strands of connective tissue must be thoroughly removed; this will enable one to lengthen the cord very materially (Fig. 2094). The dissection of the vessels should always extend as high up as the transversalis fascia or even higher, if deemed advisable.

Step 3. The site of the incision in the thigh is determined by laying the liberated testicle on it without traction beyond that which is necessary for straightening out the vessels. A point somewhat higher than the one to which the testicle reaches is chosen for the incision (Fig. 2096 b). Return the testicle into the inguinal wound. A transverse incision is now made, the mesial end of which is somewhat lower than the lateral end. It should be of sufficient length to accommodate the long diameter of the testicle and deepened to the fascia of the thigh.

Step 4. With one or two fingers create a pocket extending from the lower end of the inguinal incision to the bottom of the scrotum. Open the pocket thus formed by an incision which should correspond exactly in length and direction with that in the thigh in order that the edges may properly be united (Fig. 2096 c). Pass a strip of gauze through the tunnel thus made.

Step 5. This step consists of uniting the upper end of the wound in the thigh with the corresponding end of the wound in the scrotum. In order to avoid the knots lying on the raw surface of the wound, it is passed as shown in the Fig. 2096 d, i.e., from surface to depth at the first edge and from depth to surface at the second edge, thus bringing the knot to lie on the skin surface. The sutures are interrupted. A sufficient amount of raw surface of each flap to be adapted should be turned in. This is best accomplished by paying particular attention to the selection of the points of entry and exit of the needle, which should be such that on the skin side the stitch bite is much

closer to the edge than on the raw side; this prevents the skin from turning in—a tendency to which the skin of the scrotum is particularly prone. Rolling up of the skin prevents union. Unite the cut posterior lip of the scrotal wound with the corresponding edge of the wound of the thigh with catgut sutures as described, paying particular attention to details of suturing as outlined.

Step 6. (Fig. 2094.) Deliver the testicle from the inguinal wound through the channel created by the aid of a clamp until it emerges from the scrotal wound. Pass two fine sutures of chromicized catgut through the tunica albuginea and fascia of the thigh. Avoid injury to the saphenous and femoral veins (Fig. 2094 f).

Fig. 2095 Fig. 2096

Fig. 2095. Bilateral cryptorchidism. Torek operation. Testes anchored into the open lateral scrotum, which is attached to thigh.

Fig. 2096. Torek operation. Three months after operation.

Step 7. Unite the anterior lip of the scrotal wound to the lower lip of the wound in the thigh with fine silk or Pagenstecher linen. Here again avoid inversion of the scrotum.

Step 8. Close the inguinal canal as follows:

(a) Internal oblique and transversus muscle to Poupart's ligament. The cord is not transplanted.

(b) Where a hernia exists, the sac is treated in the usual manner.

(c) Unite the aponeurosis of the external oblique muscle; close the skin. Pull a small strip of gauze through the canal of skin existing between the scrotum and thigh. Dress the wound (Fig. 2094 g).

Allow firm union to take place. The deep layer of catgut sutures need not be bothered with. The anterior row of sutures of silk is removed on the 7th or 8th day (Fig. 2095).

Two or three months or longer should be permitted to elapse before the testicle is freed from its attachment to the thigh.

Release of the Testicle. The testicle is detached by passing a sharp scalpel through the scar, not deeper than the thickness of the tissues that were united at the previous operation (skin and superficial fascia). Lift up the

flaps; lift up the scrotal skin to a slight extent. Lay the testicle bare with anterior gentleness, by blunt dissection. Delay the dissection of the posterior part of the pair until the underlying tissues have been separated from it.

Bury the testicle in the scrotum.

Close both wounds with interrupted sutures (Fig. 2095).

In bilateral cryptorchidism, operate in two stages.

Comment. H. W. Meyer reports sixty-four cases (1926-1928) in which the success of the Torek operation was perfect in all cases. The same procedure was for operation in before puberty (8-10 years). Autumn it should be given a trial before operation is resorted to. It should not, however, be forestalled in other reasonable trial if not followed by the desired result.

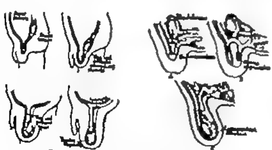


Fig. 2097 Fig. 2098

Fig. 2097. The descent of the testis.

Fig. 2098. The descent of the testis. (Courtesy of Dr. A. D. Bevan.)

Bevan Operation

The salient features of the operation are referred to in recent literature by Bevan as follows:

"I want to say that I have been a good deal surprised and a good deal shocked at the evidence of the careless way in which many medical men read descriptions of operative procedures and then, without a complete understanding or without any memory of the subject, proceed to operate in a bungling way.

"I would cite as evidence of this fact two examples. In developing the operative technic, I found that, in a small number of cases (5 to 10 per cent), I was not able to lengthen the cord sufficiently to bring the testicle down into the scrotum, without tension, unless I divided the spermatic vessels, so that in this limited number of cases, which may have been at first 10 per cent and which has since dropped down to 5 and later to 3 per cent, rather than give up the operation and push the organ back into the abdominal cavity, I divided the spermatic vessels, which enabled me to lengthen the cord sufficiently to place the testicle into the scrotum. This procedure necessarily carried some risk. Much to my horror and chagrin, I found that a number of my colleagues referred to the

division of the spermatic vessels as the Bevan operation and proceeded to do the division of the spermatic vessels indiscriminately in all cases with resulting atrophy and necrosis in a considerable percentage. As a matter of fact, I have not ligated the spermatic vessels in a single case for the last four or five years, because, with increased study and experience, I have been able, without the division of the spermatic vessels, to bring the organ down into its normal position without tension. I should not, however, hesitate a moment, in a case where it is impossible to do this, to ligate the spermatic vessels, and to bring the testicle down into the scrotum, rather than to place it back into the abdominal cavity.

As another example of the careless way in which medical men read descriptions of operations, one of my German colleagues, in referring to the purse-string suture which I place at the neck of the scrotum in front of the cord leaving ample

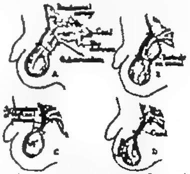


Fig. 2099. The descent of the testis. (Courtesy of Dr. A. D. Bevan.)

room for the cord behind, after sending my article stated that he thought it was bad surgery to put a purse-string suture at the neck of the scrotum surrounding the cord, because it was sure to interfere with the circulation of the testicle.

Many of us were under the erroneous impression for many years, that in order to "lengthen the cord," the division of the spermatic vessels was a part of the Bevan operation. Like others, I have, for a long time, imparted that teaching to my students, until Dr. Bevan, in his later writings, called the attention of the profession to the incorrect notions entertained on his procedure. The description for the correct technic for the operative correction of cryptorchidism can best be accomplished by citing Dr. Bevan's own language.

For a thorough understanding of the principles involved, the mechanism of the descent of the testis should be kept in mind (Figs. 2097, 2098, 2099).

"The incision made is exactly the same as that which we employ for operations of radical hernia. I am careful not to extend the incision into the scrotum, but keep it just above the scrotal tissues (Fig. 2099). I divide the skin and superficial fascia, and in the superficial fascia I divide the small arteries and veins, branches of the femoral artery and vein that pass up above Poupart's ligament,

at the lower angle of the incision the superficial pubic and about the middle of the incision the superficial epigastric.

Fig. [illegible]. The peritoneal process formed before the descent of the testis. (Courtesy of Dr. A. D. Bevan.)

Fig. [illegible]. The skin incision. (Bevan.)

After dividing the skin and superficial fascia and clamping these small vessels, I expose the glistening aponeurosis of the external oblique, and as I expose the external ring I come to the testicle which is surrounded by a large peritoneal sac and covered by the three layers of fascia found in inguinal hernias (Fig. [illegible]). I very carefully separate this peritoneal sac from the surrounding

fascial layers. I split the external oblique over the canal for a distance of about two inches well up to the internal ring (Fig. [illegible]). I am now able to bring the testicle out of the incision and place it upon an abdominal pad. By making a little traction on the testicle and the peritoneal sac surrounding it, I bring that part of the peritoneal process surrounding the cord well into view and free the cord well up into the internal ring (Fig. [illegible]).

Fig. [illegible]. The skin and superficial fascia divided. The external oblique divided. (Courtesy of Dr. A. D. Bevan.)

"The next step of the operation is to divide the peritoneal process transversely at a point about an inch below the internal ring. This requires a delicate dissection, and we have developed some operative tactics that is of value. I first split the vaginal process by a short incision, about one-half inch in length, parallel with the cord. I then place on the edges of the incision in this thin peritoneal process four small artery forceps, mosquito forceps, so as to be able to make the peritoneum tense (Fig. [illegible]). It is difficult to dissect off the peritoneal vaginal process from the cord. In order to facilitate this dissection I take a fine hypodermic needle and syringe and inject some normal salt solution under the peritoneum, so as to lift the vaginal process up from the cord (Fig. [illegible]). This makes the separation of the peritoneal process much easier. The peritoneum is so delicate in the child, being like tissue paper, that you must make a very

delicate and careful dissection. I have now completed the transverse division of the peritoneal process, and have stripped the upper part of the vaginal process well up to the internal ring. I now ligate this upper end that opens into the

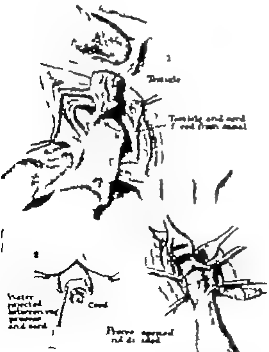


Fig. [illegible]. Freeing the testis. (Courtesy of Dr. A. D. Bevan.)

general peritoneal cavity with catgut ligature, just as we do the stump of a hernial sac (Fig. [illegible]). Picking up the lower part of the vaginal process with four dissecting forceps with teeth, I strip it down from the cord so as to

expose the entire length of the cord uncovered by any peritoneum (Fig. [illegible]). The lower part of the peritoneal pouch is used to make a tunica vaginalis for the testicle. This is accomplished either with a purse string suture or simply a running suture closing the opening (Fig. [illegible]). As I lift up the testicle and cord there is still some tension, but I find as I examine it carefully that this

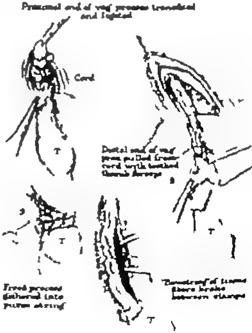


Fig. [illegible]. The Bevan operation for cryptorchidism.

tension, preventing a sufficient elongation of the cord, is due to some abnormal fibrous bands, which I now sever between dissecting forceps. These bands are derived from the fascial coverings of the cord and vaginal process. I regard this as an important step in the operation, and it is one that should be thoroughly understood (Fig. [illegible]). One can with ease divide and tear these abnormal fibrous bands, leaving simply the vas and its vessels and the spermatic vessels.

without interfering in any way with the essential structures in the cord. You will see that by this manipulation you have been enabled to free the cord, as a rule, for four or five inches, a length quite sufficient to place the testicle in the

Fig. [illegible]. The Bevan operation for cryptorchidism. (Courtesy of Dr. A. D. Bevan.)

scrotum without any tension whatever. With the index and middle fingers and blunt dissection and by packing into it sufficient gauze, I now make a large pouch in the scrotum which must be large enough to receive the testicle without compressing it in any way (Fig. [illegible]). The scrotal tissues are so elastic

and so yielding, that with the gloved fingers and gauze packing we have always been able to make a scrotum large enough to receive the testicle without pressure. The organ is now placed in this pouch, and with a purse string suture of catgut the neck of the scrotum is closed, this suture simply being one that goes through the superficial fascia and does not involve the skin or include the cord. This suture must not endanger the blood supply of the testicle (Fig. [illegible]). This prevents the testicle slipping up into the groin, and keeps it well down in the scrotum. The canal is now closed, not as in a Bassini operation, but with the cord deeply situated in the canal: the transversalis and internal oblique are sewed to the shelf of Poupart's ligament, over the cord and the external oblique is now closed (Fig. [illegible]). The skin and superficial fascia are closed in the

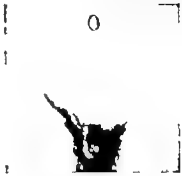


Fig. [illegible]. The result of the operation. (Courtesy of Dr. A. D. Bevan.)

same way that we would close them in a hernia operation. You will find that the organ is now in the scrotum without any tension whatever, looking very much the same as on the other side (Fig. [illegible]).

"I would like to emphasize the fact that the technic must necessarily be difficult to one who undertakes it for the first time, especially without having had the opportunity of seeing a number of these operations performed by one who has had experience with it. I would also like to emphasize the fact, from my observations of cases that have been done by some inexperienced surgeons, that the operation has not infrequently been undertaken by men who have not fully understood the technic of the procedure, and who have not carried it out in all its details. I would also like to emphasize very strongly the fact that division of the spermatic vessels is but exceptionally called for, and is not at all an essential part of the operation which I have developed, and it is in our own hands not necessary in but [illegible] per cent of the cases. On the other hand, wherever it is indicated, it should be done and thoroughly done, on the principle that the basic idea of any operation is the necessity of placing the testicle in the scrotum without any tension whatever. Care should be taken in the primary dressing of the case not to put on enough pressure over the groin to interfere with the circulation in the cord.

"On the whole, the operation seems to me to be one of the most interesting pieces of surgical anatomy in the whole field of operative surgery. The skillful handling of this congenital condition, which enables the surgeon to accomplish in a half hour by good operative technic what requires weeks and months in the process of development, with, as a rule, perfectly satisfactory results, has furnished one of the most satisfactory examples of modern surgery."

EPIDIDYMOTOMY

Hagner's Operation

F. R. Hagner has done much to popularize this operation and to stress its great value in acute epididymitis mostly of Neisserian origin.

Local anesthesia may be used (Fig. [illegible]).

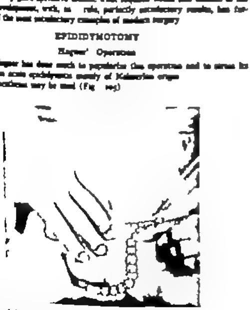


Fig. [illegible]. Infiltration anesthesia in operations on the scrotum and its contents. Observe the line of infiltration back [illegible] carried above the root of the penis which [illegible] passed by the [illegible] infiltration surrounding the scrotum.

Step [illegible]. Make an incision through the skin over the point of junction between the swollen epididymis and the testicle 4 to 10 cm. in length. This incision includes skin, fascia and tunica vaginalis which is opened longitudinally at the junction of the testicle and the epididymis.

Step 2. Deliver the testicle with its adnexae through the opening made in the tunica vaginalis. Surround it with warm compresses. Examine the affected epididymis. Make multiple small punctures in it with a sharp-pointed tenotomy—particularly where the epididymis shows the greatest induration. When the scalpel penetrates the thickened fibrous capsule of the epididymis marked decrease of resistance is perceived. If pus issues from any of the

puncture openings, that opening is enlarged and a small probe is inserted into it. Small pus cavities are washed out with a fine pointed syringe.

Step 3. The tunica vaginalis is restored to its normal position, and washed out with salt solution. Close it lightly with a few catgut sutures. Place a cigarette drain in the lower angle of the wound. Close the skin. Hot packs will stop bleeding; however, the flow of blood should be encouraged for a few minutes. This will aid in decongesting the affected area.

Comment. I have practiced this operation for many years. It certainly conduces to a more rapid recovery and causes almost immediate cessation of pain. It reduces morbidity and cuts convalescence short. When the time element is of no moment and the possibility of sterility not a factor to that particular patient, conservative measures usually suffice.

DECORTICATION

DECAPSULATION OF THE EPIDIDYMIS

In the treatment of acute epididymo-orchitis excellent results are obtained by this procedure. It is a simple procedure followed by prompt relief to the patient.

Step [illegible]. Make a crucial incision through the inflamed covering of the epididymis.

Step [illegible]. Strip the covering off the underlying epididymis as shown in Fig. [illegible].

Step 3. Evacuate any accumulated fluid in the tunica vaginalis.

Step 4. Insert a cigarette drain and close the scrotal wound.

Comment. Decapsulation may be combined with puncture (Hagner's Operation—see above).

Fig. [illegible]. Decapsulation of the epididymis by [illegible]. (After [illegible].)

EPIDIDYMECTOMY

Step 1. Incise the scrotum beginning just below the external abdominal ring and extending downward. If there are skin adhesions and fistula formations, they should be embraced in the incision.

Step 2. Deliver the testicle through the incision in the scrotum and incise the tunica vaginalis along the outer side of the line of junction of the epididymis with the testicle (Fig. [illegible]). Separate the epididymis from the testicle by blunt dissection (blunt dissector) beginning at the globus major and loosening its attachment to the testis by snipping with a pair of sharp-pointed scissors the tunica albuginea at that point. Blunt dissection permits the separation of the rest of the epididymis with facility. The blood vessels passing to the testicle lie along the inner side of the line of junction between the epididymis and the testicle (on the side of the epididymis opposite to that along which the incision has been made). Putting the epididymis on the stretch will afford the possibility of clear separation of the vessels from it,

taking care not to injure the layer of tissue in which the vessels course (inner surface of the epididymis).

Step 3. Separate, bluntly, the vas from the rest of the structures of the spermatic cord. Incise the fascia of the external abdominal oblique when the

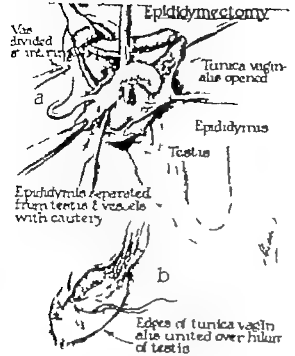


Fig. [illegible] Epididymectomy. [illegible]

external inguinal ring is reached. Free the vas from the inguinal canal as far as the internal inguinal ring. Ligate and divide the vas. Unite the divided edges of the tunica vaginalis (Fig. [illegible] b).

Step 4. Close the fascia of the external abdominal oblique with catgut sutures. Close the wound with or without drainage as indicated.

Fig. [illegible] A. [illegible] (Hinman.)

OPERATIONS ON THE TESTIS

Orchidectomy (Continued)

Step [illegible]. The incision is the same as in hernia operations, viz., parallel to and about [illegible] finger breadth above Poupart's ligament and about [illegible] cm. long,

Fig. [illegible] Drawing to show [illegible] (Hinman.)

extending to the pubic spine and dividing the skin and subcutaneous tissue. Ligate doubly and divide the superficial blood vessels. Expose the external abdominal ring and open the inguinal canal by splitting open the external abdominal oblique fascia along the line of incision.

Step [illegible]. Separate the external abdominal oblique fascia with sharp retractors. Isolate and lift up the spermatic cord. Carry dissection with it freeing it up as high as possible.

Step 3. Incise the covering of the spermatic cord. Isolate the vas deferens up to the internal abdominal ring. Clamp, ligate doubly and divide the vas. Carry [illegible] around the rest of the constituents of the cord, doubly ligate it and sever it.

Step 4. The opened inguinal canal is now closed by either interrupted or continuous sutures. Protect the wound with hot compresses and proceed to remove the testicle. The cord is followed down to the testicle which is freed by sharp dissection including its investing membranes, from the attachments to the scrotal tissues.

Step 5. Close the deep and cutaneous wounds.

Extended Orchidectomy in Malignant Tumors of the Testes

In malignant tumors of the testes an extended procedure aiming at the removal of the lymph nodes is essential, if success is to be attained. Frank Hinman proceeds as follows. (Figs. [illegible] A, B)

"The patient is better turned [illegible] to the opposite side with a small pad under the back. The cord is exposed through an inguinal incision and clamped so that the subsequent pressure and manipulation in delivering the testicle will not spread cells into the blood stream. If upon delivery of the scrotal mass, solid testicular tumor is found, castration should be completed by severing the cord below the clamp with cautery. The tumor mass [illegible] immediately sectioned by [illegible] pathologist or an assistant in order to confirm the diagnosis. Too many radical resections of retroperitoneal glands for tuberculosis or syphilis have been performed (four are reported) to warrant the omission of this necessary diagnostic step. In case of malignancy the inguinal incision is extended to the twelfth rib, [illegible] parallels. Muscle and fascia are then divided in the line of the skin incision down to the peritoneum. Beginning in the iliac fossa, the peritoneum is stripped back to and beyond the large abdominal vessels. The ureter and spermatic vessels with lymphatics strip up with the peritoneum but the lymph nodes remain upon, sometimes being quite adherent to, the vena cava and aorta. Theoretically the lymph area should be removed from above downward, but practically its clean and complete removal is more difficult in this way than by resection from below for the reason that traction on the cord greatly facilitates following [illegible] and making [illegible] clean dissection. It is probable that the cleaner, more complete removal permitted by dissecting from below upward offsets the theoretical advantage of peripheral attack. It would seem advisable, therefore to combine the methods of first isolating, ligating and dividing the spermatic vessels at their point of origin [illegible] vena cava, aorta or renal vein and then proceeding with resection of the area from below upward. Occasionally the glands may be so matted along the inferior mesenteric artery that in order to effect [illegible] clean removal, the artery must be sacrificed near its origin. The practicability of this procedure seems feasible on the basis of [illegible] series of cats and dogs in which the artery was ligated and cut near its origin without apparently the least untoward effects. This procedure was necessary in one personal case, but the patient died of acute cardiac dilatation [illegible] few hours after the operation so that the efficacy of the collateral circulation in the human could not be determined.

After completion of the resection, immediate exposure on the operating table of the retroperitoneal and iliac area to roentgen rad ... is an added protection against recurrence because of possible isolated cells or metastatic areas left behind. The placement of rubber tubes for drainage of the ... at the back or upper end of the wound, and additional ... if desired ... is used to carry radium for radiation of the resected area for twelve to fourteen hours after operation.

Fig. [illegible]. Testicular prosthesis of silver ... X-ray ... (Author ...)

Testicular Prostheses

The surgeon is often called upon to relieve psychic distress in individuals who have lost their testicles for one reason or another. Hypochondriasis frequently results and in certain well marked cases this form of introspection has led to suicide. Silver, glass, ivory, rubber, etc. have been used to imitate such ... In some cases paraffin injections have been resorted to (Cor... Hermann reported case in young man of ... years ... had lost testicle ... and who had been advised nothing could be done to remedy the condition. A mental state bordering on insanity resulted. The patient submitted to the introduction of a silver testicle into his scrotum and he recovered his mental poise ... [illegible]

children. ... is ... to ... in ... testicular prosthesis. It is easily ... and is well tolerated by the tissues. Figures ... depict respectively a silver and aluminum prosthesis introduced by the author for psychic depression resulting from absence of the testicle in the scrotum. In both cases excellent results followed.

Fig. [illegible]. Testicular prosthesis of aluminum in scrotum.

OPERATIONS ON THE SPERMATIC CORD

Torsion of the Spermatic Cord

Mechanical strangulation of the spermatic cord, by torsion on its long axis, may interfere sufficiently with the circulation of the testicle to produce ... in the cord itself, in the testicle or in both. The condition probably occurs ... with greater frequency than ... of the literature would suggest, but owing to its simulating other conditions, the correct diagnosis often is not made unless operation is carried out (Fig. [illegible]).

The first case seems to have been reported by ... in ... cases. ... collected forty four cases ... and ... reporting in ... could find only ... cases but O'Conor in 1919, found the number of cases increased to ...

In recent cases the condition has been much more frequently reported ... at the Bellevue Hospital, New York City, found seven cases in the records there. ... observed three personal cases and in my own practice I have operated upon the same number ... one of which I reported in [illegible]

[illegible]

Although some authors seem to consider that orchidectomy is not called for if torsion of less than twenty-four hours duration, I do not think that any arbitrary rules can be laid down. The clinical findings ... (not attempt at ... must be the surgeon's guide, no matter how long the torsion may have lasted.

There are two well-recognized types of torsion of the cord: the acute and the recurrent. The acute type is that in which the symptoms are so fulminating that the wrong diagnosis is often made and the true condition only discovered at operation. The recurrent type is more likely to be correctly diagnosed if

Fig. [illegible]. Torsion ... recurrent ... showing ... of parts surrounding the cord

... history is taken and epididymitis is ruled out. In this type the symptoms are not so severe as in the acute type and the condition subsides after spontaneous untwisting—until the occurrence of a new attack.

Orchidectomy seems to be the proper procedure in the majority of cases.

In ... case I recently operated on (March 1928) detorsion and fixation of the testicle and cord were done. At present writing (September 1928) the testicle seems to have atrophied.

OPERATIONS ON THE MALE URETHRA

Anatomic Considerations. The male urethra is about 8 inches long. It is divided into the following parts: (a) cavernous or spongy (pars cavernosa), (b) membranous (pars membranacea), and prostatic (pars prostatica).

For clinical purposes the urethra is divided into an anterior and posterior portion, the former comprising the spongy portion, the latter the prostatic portion. They are separated by the membranous urethra. This part of the urethra is situated be-

tween the layers of the triangular ligament and is surrounded by the compressor urethrae muscle. The narrowest parts of the urethra are the external meatus and the

... of bladder and male urethra, exposed by opening and ... the ... wall ... to ... surface of prostate, membranous, and beginning of cavernous ... of urethra.

membranous part, the widest ... the fossa navicularis, the bulbous urethrae (bulb) and the prostatic part ... (Fig. [illegible])

Fig. [illegible]. Stricture of the urethra. Note false passage, dilatation of the prostatic ducts, and ... of the bladder.

Normally the ... the ... to the external meatus. ... [illegible]

the bulb; they are almost unknown in the posterior urethra. Traumatic strictures are usually found in the membranous urethra.

URETHROSCOPIC DIAGNOSIS AND TREATMENT

In recent years, remarkable progress has been made in the diagnosis and treatment of urethral disease. Study of pathology of the urethra brought to light many hitherto obscure distressing urologic manifestations.

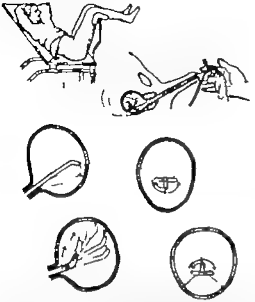


FIG. [illegible]. Posture of patient for cystoscopy. 2. Scissors and bladder. By ... the bladder from the end of the cystoscope ... Method of examining the trigone, ... Arrows show how leads of cystoscope ... 4. Diagram ... the trigone and lateral walls of the bladder ... back of the cystoscope ... the trigone and lateral walls of the bladder.

Urethral instrumentation should never be done without proper preparation of the patient and instruments. Examination must be omitted in all acute inflammatory conditions of the lower urogenital tract as well as in certain malformations of the urethra. Hypersensitive patients offer real problems in this connection.

Instruments for examination of the urethra include sounds, filiform bougies, catheters, endoscopes, panendoscopes, urethroscopes and cysto-urethroscopes. Due to the ever-increasing models, it is quite impossible to illustrate them all. A simple type of endoscope is the Koch instrument. Variations consist mainly in the manner of lighting, some being direct and others indirect.

Position and Preparation of the Patient. The patient having emptied his bladder lies prone on his back at a 45-degree angle with his or her feet in stirrups. (Fig. [illegible].) The external genitalia are thoroughly cleansed with green soap and water after which an antiseptic sponge is placed between the labia in females and sponged over the meatus and vicinity in males. Potassium-mercuric iodide, bichloride and lysol are some of the antiseptics used. Anterior urethral irrigation is occasionally used in the male.

Anesthesia is usually not necessary for ordinary instrumentation. Thorough lubrication and an experienced touch are prime requisites. However when painful areas are encountered or in operative procedures, anesthetization of the urethra, hypodermic injections of morphine or even general anesthesia may have to be resorted to in some cases. Caution must be exercised in urethral medication and instrumentation. Fatalities have been reported from injections of novocaine and oil embolism resulted from the oil used for lubricating the instruments.

Preparation of Instruments. Careful sterilization of instruments is essential. Transmission of infection from stock jars of lubricant and instruments is an ever present source of danger. K. Y. jelly, oil or sterile glycerine are the most common lubricants used. While sterile gloves are dispensable for ordinary passage of catheters, sounds or endoscopic instruments, care must be taken to avoid contamination of that part of the catheter or instrument entering the urethra. Gloved hands however are good insurance for both patient and surgeon alike.

Endoscopy

Urethroscopes commonly used are of two general kinds: 1. endoscopes which are simple straight tubes; one type carrying a light at the lower, the other at the outer end. 2. Urethroscopes, cysto-urethroscopes and panendoscopes which are closed tubes permitting the use of water or air inflation. (Figs. [illegible].)

Endoscopes are used principally for topical application; the same instrument may be used for both men and women. In the male the instrument is introduced in such a manner that its tip follows the urethral curve without using any force. At times the urethra must be anesthetized with a 4 to 6 per cent novocaine solution which is held in situ for five minutes. Prior appropriate sounds to dilate the constricted end of the urethra. Meatotomy may have to be performed in certain instances. Spasm of the sphincter vesicae is overcome by holding the instrument in situ for a few minutes until relaxation takes place after which the instrument usually slips into the bladder.

The obturator is now withdrawn and the area to be treated is swabbed with dry cotton sponges, as needed. Adjust the light of the instrument; slowly withdraw the endoscope and while so doing, inspect in sequence, the neck of the bladder, trigone, urethral canal, vera montanum and ejaculatory ducts and finally the orifices of the urethral glands. Never push the instrument upward without the obturator in place. Considerable damage may result from disregarding this precaution.

In the female, the knee chest position with atmospheric air inflation of the bladder may afford opportunities for treatment of the commonly common lesions

at the neck of the bladder. The most sensitive portion of the female urethra is the meatus; this may be satisfactorily anesthetized with novocaine or cocaine by simply inserting a cotton swab saturated with a 4 per cent solution of cocaine left in situ for a few minutes. Urethral caruncles, strictures and prolapse of the urethra are frequent occurrences and should be sought for first. If simple methods, such as dilatation or cauterization fail, operative procedures may become necessary to remedy the condition.

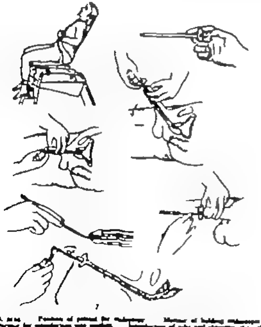


FIG. [illegible]. Position of patient for endoscopy. ... Method of holding endoscopic tube and obturator for introduction into urethra. ... Introduction of tube and obturator through the anterior urethra down to the cut-off muscle. ... Manner of introducing tube and obturator through the posterior urethra. ... Technic of clearing and drying urethra. ... Manner of using ... for drainage of urethral sinus. ... Technic of removing broken catheter from deep portion of urethra. ... relative position of endoscope and forceps, body ...

Cystoscopy

Ordinary cystoscopes are of the following types:

Observation and catheterizing cystoscopes.
Operating cystoscopes ... 24 F.

3. Cysto-urethroscopes.
4. Smaller caliber instruments for infants ... 16 F.

The preparation of the patient is the same as for urethral instrumentation. A very satisfactory method in the male is to inject about an ounce of 3 or 4 per cent novocaine solution into the bladder and into the posterior urethra. (Fig. [illegible].)

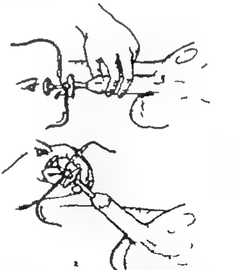


FIG. [illegible]. 1. Posterior urethroscopy. The ... and ... inserted in the ... in order to see the roof of the urethra. A, bladder side for lens. B, ... 2. ... Anterior urethroscopy.

Close the meatal end of the urethra for about three minutes with the fingers; satisfactory anesthesia usually results. Besides local caudal or spinal anesthesia, gas or the intravenous administration of evipal anesthesia may be resorted to.

In women a pledget of cotton saturated with novocaine is usually sufficient. Sensitiveness to novocaine should be ascertained beforehand and reactions should be met with phenobarbital hypodermically.

In operative procedures or even in urethral catheterization aseptic precaution is essential as in any other operative manipulation elsewhere in the body.

The instruments to be used should first be tested as to degree of light, clarity of lenses, etc. The cystoscope should be passed gently into the urethra

on a sound, amply lubricated. In the female no resistance is usually encountered as the urethra is short and straight. In the male, resistance may be encountered at the neck of the bladder; this may be due to spasm, enlarged prostate, etc., and the tip of the cystoscope may have to be lifted by a finger in the rectum; this must be remembered in swinging the shaft of the instrument into correct position successfully; entrance is never accomplished by forceful pushing.

Once the cystoscope is in the bladder, withdraw the obturator; determine the quantity of residual urine, note its character. Inject enough sterile water into the bladder to permit vision; the patient should not experience discomfort. If the fluid is cloudy or bloody, irrigation may be made by simply allowing it to pass in and out. The examination is begun as soon as the bladder starts filling with water. The patient's sensibility or the obliteration of the folds of the bladder is the signal for shutting off the inflow of water.

Follow a definite system of inspection lest an unsuspected lesion be overlooked in urethroscopy and cystoscopy (Figs. [illegible]).

A good method to pursue is to locate the air bubble at the upper end of the vault of the bladder, bring the cystoscope forward, inspect the vault, fundus, ureteral orifices, neck, and trigone of the bladder. Certain instruments permit the examination of the posterior urethra by withdrawing the instrument from the bladder.

Through the operating cystoscopes, various procedures are possible (fulguration of bladder tumors, crushing and removing small or large stones by means of the lithotrite, etc. (Figs. [illegible])). These lithotrites are of two types: (a) blind, e.g., directed by the sense of touch; and (b) direct vision.

Ureteral Catheterization

This is the final step in urologic examination in so far as instrumentation is concerned (Fig. [illegible]). The ureteral orifices having been inspected in the manner cystoscopic examination, the catheters, usually about No. 5 or 6 [illegible], are passed into the right and left ureteral orifices respectively. It is important that the two catheters are not similar. A simple method is to cut one obliquely at its distal end and leave the other straight. The catheters must be sterile and previously tested as to patency. The appearance of the ureteral orifice sometimes gives information of existing pathology. In tuberculosis, "golf hole" appearance is characteristic while edema and redness indicate infection or stasis. The ease of passage, the presence or absence of obstruction is carefully noted as the catheters are inserted. The character of the flow of urine and its appearance is also observed. Temporary anuria owing to instrumentation is overcome by slight withdrawal of the instrument, injection of fluids or the introduction of a small amount of sterile water and its aspiration. Specimens are collected in sterile tubes and sent to the laboratory for culture, smear, etc. Indigo carmine is next injected intravenously to determine the relative kidney function. Phenolsulphonphthalein may also be used. The dye is usually excreted in from three to six minutes in normally functioning kidneys. In pathologic conditions the dye is absent on one side, delayed, or the concentration is poor. If the flow of urine has been scant and continuous previous to injection of the dye, there is very little chance of a temporary inhibition confusing the picture.

In the presence of anomalies, it is sometimes necessary to catheterize three

or even four ureters at the same time. Such occurrences, however, are not very frequent.

Roentgenography is the next step in diagnosis. Occasionally a simple flat plate with the ureteral catheter in place may rule out a shadow by placing it

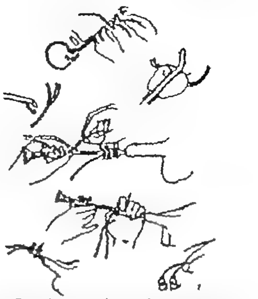


Fig. [illegible]. Technic of catheterization of ureters. [illegible]

out of the ureteral line. Stereoscopic images may also be resorted to. Retrograde pyelography is accomplished by the injection of [illegible] cc. of pyelographic media. Skiodan, hippuran, sodium iodide in [illegible] per cent solution or sodium bromide may be used. The amount used varies from [illegible] cc., although usually [illegible] cc. suffices.

The indications for taking a pyelogram are diagnostic purposes or to correct interpretation. It is contraindicated in tuberculosis, and in acute infections

Study should be delayed for a safer period. Also, the patient's reactions should be watched and prolonged manipulation avoided.

[illegible]

Intravenous pyelography is indicated in all cases in which cystoscopic and ureteral pyelography are impossible or contraindicated because of the general condition of the patient or for anatomic or pathologic reasons.

[illegible]

LOCAL ANESTHESIA OF THE URETHRA

In instrumentation of the anterior urethra, in hypersensitive cases, it is not necessary to fill the anterior urethra with solution in order to make the application complete. [illegible]

[illegible]

unnecessary and inappropriate to anesthetize the anterior urethra; likewise the bladder, per se. Under these circumstances the posterior urethra is the exact location demanding anesthesia. It is precisely this area that is tender and that offers resistance to the approaching cystoscope or sound.

A method that provides a confined application of any anesthetic drug selected, and is concentrated there, must be the method of choice. Bransford Lewis states, "I have been using such a method for about twenty-five years, and have never seen a single instance lead anything to occur to disturb my conviction that it is by far the best and safest of all methods for local urethral anesthesia. It consists in the use of readily soluble tablets of either novocaine, alypin or cocaine deposited in the urethra of either male or female, at any desired point. For cystoscopy in the male the point of election is the posterior urethra—just past the external sphincter. The means of depositing the tablets is furnished by a very simple little instrument, a urethral tablet depositor (Fig. [illegible]) which I submitted to the profession about twenty-five years ago and which has proved the most frequently used instrument in our armamentarium since then. [illegible] when alypin was introduced by the Schieffelin Company with the claim of less toxicity [illegible] it, I used it until the recent war took it off the market. Since then I have used novocaine tablets, [illegible] supplied in proper size and shape by the [illegible] Laboratory. I have no idea how many thousands of these I have made use of this method, but assuredly more than enough to establish my belief in its safety and its efficiency. The depositor with novocaine tablets is prepared and used with all urethral instrumentations that are liable to cause pain, including dilatings, deep endoscopies, cystoscopies, deep urethral [illegible], [illegible], [illegible] to urethra or bladder, [illegible], etc. If there were danger in it I should assuredly have encountered that fact in twenty-odd years' use. It is applicable to both men and women.

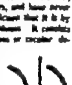


Fig. [illegible]. Bransford Lewis improved tablet depositor for local anesthesia of the urethra.

"Technic. The tablet method for urethral anesthesia is so simple and obvious that it would seem hardly necessary to describe its technic; yet there are some details that ought to be mentioned that might, indeed, meet some of the theoretical objections that must be entertained in the minds of those who have never taken it up.

"In ordinary routine cases it is not necessary, either in the male or female, to use any solution preceding the dropping of the tablets at the site desired. In these the depositor with the obturator is withdrawn, the tablet inserted into the funnel-shaped opening and pushed through the tube with the obturator. The obturator for the past several years has been made with a flexible shaft that prevents its 'bumping' at the tube. The tablet is permitted to dissolve in the mucus of the urethra for a half-minute or so, when by to and fro motions of the depositor the pasty-liquid mass of tablet is smeared over the adjacent membrane. If one or two tablets are not enough to produce the desired effect, as determined by the patient himself, an additional one or two may be used, after which the cystoscopy or instrumentation may be proceeded with. In supersensitive cases,

in which, for instance, the introduction of even a soft rubber catheter cannot be borne, 10 minims or so of 5 per cent novocaine solution may be injected with the air cushion, as previously described, or with the deep urethral syringe, depositing the fluid along the urethra as the syringe is withdrawn. Of course, the captious might say that this in itself furnishes the anesthesia, but it does not. It supplies only enough anesthesia to reduce the supersensitiveness to reasonable proportions; after which the departing does the rest. If the sensitiveness of the patient is so great that even these measures do not suffice, caudal anesthesia or preliminary hyoscine 'twilight sleep' may be resorted to, but this is seldom necessary.

Fig. 2118. Urinary extravasation. (Bahney.)

EXTRAVASATION OF URINE

"When the urethra has given way behind a stricture and urine has become diffused into the cellular tissue, very prompt and vigorous measures are necessary" (Sir Benjamin Brodie). (Figs. 2118 to [illegible])

The two important factors are most promptly noted are: First, local [illegible] aroused, [illegible] treatment against toxemia. Urinary urethral phlegmons tend to spread toward the posterior scrotal septum. Careless incisions in the perineum to remedy urinary extravasation without respect to [illegible] have claimed many victims. Proper free incisions and proper drainage are of utmost importance. (Fig. [illegible]) A perineal cystostomy is regarded by some as a much safer procedure than a suprapubic cystostomy which according to Hamilton Bailey should never be done. He outlines the following line of procedure:

1. Wash out the urethra. Instill procaine solution.
2. Attempt to pass a bougie into the bladder. In doing this, be very gentle lest perforation of the urethra occurs. "However it is usually possible to pass a No. 3 or 4 French" (Bailey). If a bougie has been passed, it should be tied in position.
3. A perineal urethrotomy is performed.
4. If impossible, Cock's operation is practiced. The infiltrated cellular tissues must be thoroughly drained. The incisions must be of sufficient depth to penetrate the bulging fascia.

Fig. 2119. Urinary extravasation with necrosis of the skin of the scrotum following [illegible] [illegible]. Suprapubic cystostomy. Deep long incisions in the infected area. [illegible]

5. Jeppe has shown that anaerobic microorganisms are largely responsible for the advancing cellulitis present in these cases. Hydrogen peroxide is, therefore used freely, introduced through an irrigating syringe.
6. Moist dressings of Dakin solution are very beneficial.

OPERATIONS FOR STRICTURE OF THE URETHRA

Meatotomy

Step 1. Introduce a probe-pointed knife (meatotome) (Fig. 2120) into the urethra (after injecting some anesthetic solution first) for about three-quarters of an inch or to a point immediately behind the narrowed portion.

Step 2. Make an incision in the median line below, not allowing the incision to penetrate to the exterior—otherwise a hypospadias may result.

Gradual Dilatation

This is accomplished by means of graded urethral sounds introduced at intervals. (Figs. 2121 [illegible])

Internal Urethrotomy

This operation is used when the patient cannot be treated for one reason or another by gradual dilatation of the stricture (preferable method) and when rapid results must be obtained.

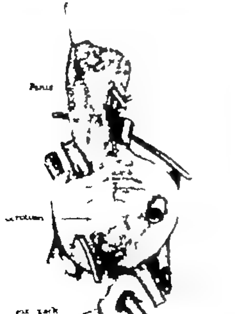


Fig. 2120. Urinary extravasation following the passage of a false passage as a result of faulty urethral instrumentation. Careful free incisions. Proper drainage. Recovery.

Preparation of the Patient. A few days preceding the operation the patient is given urotropin or cystopurin. Immediately before the operation the parts are thoroughly washed with soap and water and the urethra is irrigated with mild antiseptic solution and a teaspoonful ( ) of sterile olive oil is introduced into the urethra. The operation may be done under local anesthesia.

The methods of procedure consist of:

(a) division of the stricture from before backward, or
(b) division of the stricture from behind forward.

In the latter case the stricture must be large-calibered or dilated to a caliber sufficient to permit the passage of the urethrotome.

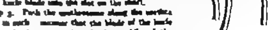


Fig. 2121. Evans' urethrotome.

DIVISION OF THE STRUCTURE FROM BEFORE BACKWARD (MAISONNEUVE'S OPERATION)

Step 1. Pass a filiform guide through the stricture.

Step 2. Attach the metal staff of the Maisonneuve urethrotome (Fig. 2122) to the guide by screwing the end of it into the metal cap upon the outer end of the filiform bougie. Pass the staff with the guide thus attached through the stricture while pulling on the penis and meatus. The staff is made to slowly pass the stricture until its point has reached the interior of the prostatic urethra. Enter the knife blade into the slot on the staff.

Fig. 2122. Urethral sounds.

Step 3. Push the urethrotome along the urethra in such a manner that the blade of the knife is kept in contact with the middle of the roof of the urethra. The knife blade being blunt at its apex, cannot injure the normal urethra, its distal end being the cutting one which divides the stricture when pressed upward. A sensation of release of the obstruction denotes to the surgeon that the stricture has been divided. Unless imperative, do not carry the knife blade beyond the posterior part of the bulb [illegible] into the membranous urethra (containing the external sphincter) which should not be divided in internal urethrotomy. Considerable hemorrhage may be caused.

Step 4. Withdraw the staff and guide. Irrigate the urethra through a small rubber catheter.

Step 5. Pass a steel sound the normal size of the urethra of the individual operated upon.

Comment. The merit of the operation is that it can be used on any stricture which permits the passage of a filiform bougie.

DIVISION OF THE STRUCTURE FROM BEHIND FORWARD (OTIS' OPERATION)

Step 1. Do a meatotomy. Determine the extent and location of the stricture or strictures with a urethrometer (Fig. [illegible]) or bougie à boule (Fig. [illegible])

Step 2. Pass the Otis urethrotome (Fig. [illegible]) with the blade closed and with the knife in position in the slot in the other end of the shaft. Pass the stricture so that the concealed blade of the knife comes to be just a little

Fig. [illegible]. Dilatation of urethral strictures (above). Introduction of first filiform bougie (below). Additional filiforms introduced.

beyond the posterior limit of the stricture to be divided. Steady the penis. The shaft of the urethrotome must be in position so that the incision of the stricture is on the roof of the urethra, in the midline. By means of the screw at the proximal end of the instrument, separate the blades so as to put the

tissues of the stricture on the stretch without tearing them. The knife concealed up until the present time, is made to appear. It is drawn steadily along the slot until all strictured tissue is divided. Sheath the knife blade again. Bring the two arms of the shaft into apposition by turning the screw head in the opposite direction used for their separation. Slowly and constantly withdraw the instrument lest injury to the urethra occur by catching a portion of mucous membrane which may be torn off during the withdrawal.

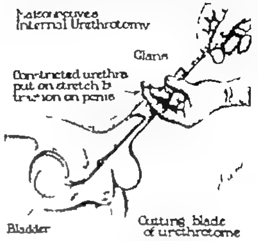


Fig. [illegible]. Internal urethrotomy. [illegible]

If the instrument is stopped during its withdrawal open the blades slightly, push it backward a little, close it again and slowly remove it.

Step 3. Irrigate the urethra and the bladder. Pass a full-sized sound.

COMPLICATIONS OF INTERNAL URETHROTOMY

(1) Hemorrhage. This may be avoided by cutting exactly in the median line of the stricture on the roof of the urethra. Sclerosed tissues do not bleed much. When bleeding is severe, pass a full sized catheter. If persistent it may become necessary to splint the urethra by external pressure against the catheter. Avoid operations by this method in the membranous urethra; retrograde hemorrhage into the bladder may ensue. In view of this, internal urethrotomy should be reserved for strictures in the pendulous and anterior part of the bulbous urethra. When the hemorrhage becomes alarming do a perineal section, expose the blad-

ing point, ligate. If all this fails drain the bladder (perineally) with a large tube and pack the wound thoroughly.

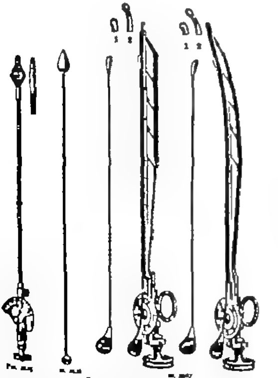


Fig. [illegible]. Fig. [illegible]. Fig. [illegible].

Fig. [illegible]. Lead [illegible]. Fig. [illegible]. Bougie [illegible]. Fig. [illegible]. [illegible]

(2) Urethral Fever. Prophylaxis (urotropin). Rapid [illegible]. Irrigate the bladder with a mild antiseptic solution immediately following the operation and leave a few ounces of the solution in the bladder (Keyes).

Keep the patient in bed for a few days. Pass a catheter for urinary retention. After five or seven days, pass a full-sized sound and pass sounds every two or

three days thereafter. Decrease gradually the time between passing sounds until satisfactory results are obtained.

External Perineal Urethrotomy

PERINEAL SECTION—THE BOUTONNIÈRE

With a Guide—Syme Operation

The object of this operation is to pass a grooved Syme staff through the stricture and cutting upon this immediately in front of the obstruction and then dividing the stricture.

Preparation of the Patient. Either by tying a filiform bougie overnight into the urethra or by gradual dilatation, the stricture is made as large as possible to facilitate ease of operative maneuvers.

Fig. [illegible]. Lahey [illegible] Steel sound with filiform guide.

Prepare as for internal urethrotomy (scrub, shave, antiseptize the perineum, testicles and scrotum). Place the patient in the lithotomy position. Have on hand a Syme's staff and filiform whalebone bougies. General anesthesia.

Step 1. Pass the thin portion of the Syme instrument through the stricture until its shoulder becomes arrested at the stricture. An assistant holds the staff vertically in the middle line. With his left hand, the assistant pulls the scrotum up and out of the way.

Step 2. Palpate the sound through the perineum. Make an incision in the median line from a point just behind the scrotum to about an inch in front of the anus, cutting through all the tissues down to the staff. This opens the urethra immediately anterior to the stricture. Retract the edges of the urethral wound with fine forceps or a couple of fine sutures introduced for this purpose (Fig. [illegible]).

Step 3. Split the stricture completely by carrying the point of the knife along the groove of the staff, in the middle line. The urethra should be divided as far back as the beginning of the membranous portion.

Step 4. Pass a Teale's gorget through the perineal wound into the posterior urethra as far as the stricture. Withdraw the staff. A finger may be passed along the gorget into the bladder. The tight margin of the cut-off muscle is first felt and through this, the finger is gently but firmly pressed; the prostatic urethra is passed after which the neck of the bladder is encountered. Explore the urethra from the front.

Step 5. A perineal drainage tube is introduced into the bladder and the gorget withdrawn. Flush out the urethra with boric acid solution after which the

[illegible] Jour. Med. Sci., Oct., [illegible]

in which, for instance, the introduction of even soft rubber catheter burns, to moisten or so of 5 per cent novocaine solution may be injected per catheter, as previously described, or with the deep urethral syringe, the fluid along the urethra as the syringe is withdrawn. Of course, the might say that this in itself furnishes the anesthesia; but it does not. It only enough anesthesia to reduce the supersensitiveness to reasonable pr after which the depressor does the rest. If the sensitiveness of the p great that even these measures do not suffice, caudal anesthesia or hyoscine "twilight sleep" may be resorted to, but this is seldom nece

Fig. 918. Urinary extravasation. (Bailey.)

EXTRAVASATION OF URINE

"When the urethra has given way behind stricture and ur diffused into the cellular tissue, very prompt and vigorous mea sury" (Sir Benjamin Brodie). (Figs. 8, 19.)

The two important factors one must promptly meet are septicemia spread, institute treatment against toxemia. phlegmons tend to spread toward the posterior scrotal region. C in the perineum to remedy urinary extravasation without supra have claimed many victims. Proper free incisions and proper utmost importance (Fig. 20). A perineal cystostomy is m as much safer procedure than suprapubic cystostomy wh Hamilton Bailey should never be done. He counsels the follow cedure

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Internal Urethrotomy

This operation is used when the patient cannot be treated (another by gradual dilatation of the stricture (preferable or rapid results must be obtained

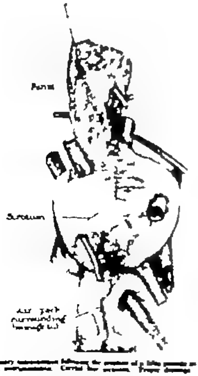

Fig. 920. Urinary extravasation following the ... of a false passage ... urethral instrumentation. ... Proper drainage ...

Preparation of the Patient. A few days preceding the operati ... given urotropin or cystokal. Immediately before the operation ... are thoroughly washed with soap and water and the urethra is irrigat ... mild antiseptic solution and ... teaspoonful (4.0) of sterile olive oil is i ... into the urethra. The operation may be done under local anesthesia.

Step 4. Close the superficial perineal wound with sutures or leave it open to heal by granulation.

After-Treatment. The soft rubber catheter is permitted to remain in the bladder for about one week. When it causes irritation it is removed earlier. After the catheter is removed the passage of sounds is commenced gradually.

Comment. Young's procedure consists of opening the urethra in front of the stricture which is found by a filiform introduced through it. The filiform is withdrawn and a delicate grooved director is introduced and the stricture divided with a sharp knife. Resection of the stricture is accomplished by thorough ablation of the cicatricial mass leaving a narrow bridge

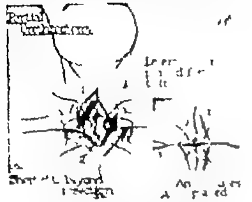

Fig. [illegible]. Albarran method of partial urethrectomy. After the lateral urethral sutures [illegible] are tied, they are used as traction sutures while the anterior sutures [illegible] are placed.

of mucous membrane connecting normal anterior and posterior portions of the urethra. The soft tissues are united fairly tight over a large catheter introduced into the bladder through the meatus, closing the defect completely. A second row of catgut sutures reinforces the first. The skin and subcutaneous tissues are closed completely except at the anterior angle where a small drain is inserted. The catheter in the bladder is fastened in place. The bladder is irrigated. The catheter is permitted to remain for about a week unless suppuration supervenes. Beginning on the twelfth day dilatation with urethral sounds is begun; the procedure is repeated every fourth or fifth day until the desired results are obtained.

[illegible] OPERATION

Rationale. It has been shown that the male urethra can be divided from the meatus to the membranous portion and healing will take place without stric-

[illegible]

ture formation, provided that sufficient perineal drainage is instituted during the healing process.

Operation

Step [illegible]. High lithotomy position. An incision with its apex at the central point of the perineum is made. Open the bulbocavernous fascia. The external anal sphincter is detached at the central tendon from the bulbocavernosus muscle. Retract the sphincter with a bifid retractor backward. Expose the membranous urethra and the apex of the prostate by pulling forward the bulb of the urethra and the transverse perineal muscles. Open the membranous urethra longitudinally. Introduce a silk traction suture on each side of the wound. The urethra is split forward toward the stricture.

Step 2. Introduce a guide or sound through the meatus to the face of the stricture and at that point also divide the urethra longitudinally in front of the stricture in the median line, the incision meeting the apex of the first incision. The urethral wound is also separated by lateral traction sutures. The exposed stricture is examined and [illegible] the urethra is found behind it and with the stricture split open for an inch or so.

Step 3. The stricture is now excised completely together with its extraurethral scar tissues; the removal of the latter must be thorough.

Step 4. The divided ends of the urethra are mobilized by undercutting. They are then united with fine interrupted catgut sutures.

Step 5. A catheter is placed into the bladder through the perineal wound and there anchored with sutures. The lateral perineal wounds are united with deep silkworm gut sutures. No sutures are placed in the perineum in front of the catheter.

Step 6. Remove the catheter from the bladder in about [illegible] week. After healing has taken place (several weeks), sounds (full-sized) should be passed.

REMOVAL OF FOREIGN BODIES FROM THE URETHRA

The technic of removal of foreign bodies from the urethra depends upon the type of foreign body and upon its location. As a general rule methods should be employed that will not injure the mucous membrane of the urethra. Stones arrested in the urethra on passage may be removed by Brown's method. This consists of first injecting an anesthetic solution into the urethra. The patient is asked to urinate; the stream of urine is then suddenly interrupted by compressing the end of the penis. This dilates the urethra and when urination is resumed the stone may be swept out.

Stones May be Removed With an Alligator Forceps

Needles or pins in the urethra may be effectively dislodged and removed as shown in Fig. [illegible].

RUPTURE OF THE URETHRA

Usually ruptures of the urethra occur in the membranous portion. It is of utmost importance to know whether the rupture is complete or incomplete. A minor incomplete rupture of the urethra may heal spontaneously. In more severe injuries, the sooner operation is undertaken to repair the damage, the better.

Catheterization per urethram often leads to trouble (infection, etc.). Suprapubic cystotomy is indicated (p. [illegible]).

Incomplete Rupture

Perineal drainage will often prevent stricture formation in incomplete rupture of the urethra without extravasation of urine.

Step [illegible]. Suprapubic cystotomy (p. [illegible]).

Step [illegible]. Retrograde catheterization.

Step 3. Open the perineum. Search for the ends of the divided urethra. [illegible]

Step 4. Suture the mobilized urethral ends by the method described above (p. [illegible], Fig. [illegible]). Use interrupted sutures of chromic catgut. To prevent the sutures from cutting out, a firm grip of the corpus spongiosum as well as the mucous membrane should be taken. (Hamilton Bailey.)

Fig. [illegible]. Proper method of removing [illegible] pin from the urethra.

Step 5. Pack the wound tightly with gauze. Drain. Take the patient down from the lithotomy position. Sutures a de Pezzer catheter into the suprapubic wound.

Comment. Further treatment after the operation and strict asepsis are essential. Begin passage of bougies after fourteen days—gently, gently.

Complete Rupture of the Urethra with Extravasation of Urine

Suprapubic cystotomy.

2. Retrograde catheterization.

3. Perineal incision. Pass a Coudé catheter from the meatus into the perineal wound. It is then threaded into the posterior urethra guided by the retrograde bougie.

Fix the catheter to the penis.

5. Drain the space of Retzius.

6. Leave the perineum open. Incise the infiltrated areas as described above under extravasation of urine.

OPERATIONS ON THE PENIS

Anatomic Considerations. The penis is composed of three cylindrical masses of erectile tissue—two corpora cavernosa on the dorsal surface and one corpus spongi-

sum on the ventral surface of the organ. The corpora cavernosa are attached posteriorly to the rami of the ischia and pubes and terminate as blunt ends anteriorly; the corpus spongiosum commences at the bulb, at the central point of the perineum posteriorly and ends in the glans penis anteriorly. Thus, the glans [illegible] the expanded portion of the corpus spongiosum and covers the ends of the corpora cavernosa. Its expanded rim [illegible] known as the corona glandis, the groove immediately behind [illegible] the collum glandis. An artery courses in the center of each corpus cavernosum. The skin of the penis is thin and loosely attached throughout. Beyond the corona glandis [illegible] forms a reduplication known as the prepuce which is attached by its inner layer to the neck of the penis. A median fold is formed by the prepuce on the under surface of the glans which [illegible] known as the frenulum; this extends forward to the lower part of the external meatus. Buck's fascia [illegible] fibrous sheath which surrounds the corpora cavernosa and corpus spongiosum, binding the three together. Anteriorly [illegible] continuous with the suspensory ligament and posteriorly with the deep layer of the superficial fascia (Colles' fascia) and with Scarpa's fascia on the abdominal wall. The corpora cavernosa and corpus spongiosum have each a separate fibrous sheath separating the two corpora cavernosa by an septum pectiniforme. The suspensory ligament of the penis extends from the symphysis pubis to the adjoining part of the dorsum of the penis.

Vessels and Nerves. The superficial dorsal vein [illegible] situated within the superficial fascia in the midline and extends along the dorsum of the penis toward the pubes. Its right and left branches join the external pudic veins. After entering the pelvis [illegible] joins the prostatic venous plexus. In the groove between the corpora cavernosa are situated the one dorsal vein and the two dorsal arteries, the vein occupying a central position. In the body of the penis are two arteries of the corpus cavernosum, terminal branches of the internal pudic [illegible] the septal vessels.

Lymphatics of the Penis and Urethra. The superficial lymphatics of the penis accompany the dorsal vein and end in the superficial inguinal nodes. The deep vessels originate in the glans penis. They also run with the dorsal vein and drain into the deep subinguinal nodes, one duct passing up the inguinal canal to terminate in the external iliac nodes. A very complex drainage occurs in connection with the urethra. The prostatic portion terminates in a similar manner to that of the prostate gland; the bulbous and membranous parts emptying in the hypogastric or external iliac chains while the penile group accompany the dorsal vein of the penis, to terminate in the deep subinguinal and external iliac group of nodes.

PHIMOSIS

The following principal factors come under consideration in the treatment of phimosis:

[illegible] To remove the constricted prepuce.

b. To have the preputial orifice sufficiently large to permit its easy retraction over the glans penis.

[illegible] To obviate injury to the frenulum.

Anatomic Considerations. It must particularly be remembered that (1) the foreskin (prepuce) is made up of an outer layer of skin and an inner layer of mucous membrane. These two are separated by a loose network of connective tissue permitting the skin to freely move over the mucous membrane. A clamp, therefore, placed upon the foreskin as practiced in certain operations for phimosis engages only the outer layer of the prepuce while the inner (mucous membrane) requires a separate incision.

(2) The integuments of the prepuce and penis are extremely loosely attached to the underlying structures, while the mucous membrane, on the contrary, is firmly attached just behind the corona glandis. It is for that reason that the former can be drawn toward the preputial opening. In circumcision care must be taken not to pull the foreskin too far forward; the clamp is applied at the point of junction

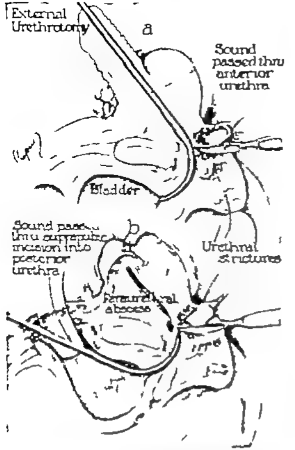

Fig. [illegible] External urethrotomy. a, With guide. Sound passed anteriorly [illegible] [illegible]

bladder is irrigated through the tube with the same solution. The perineal tube is then withdrawn until its edge just rests within the bladder. Pain and spasm result when the tube projects too far into the bladder. To make sure just at which point the tube is in its proper location in the bladder, fill the latter with fluid, draw on it until the flow ceases, then push it back again. When the flow starts, the tube is in its proper location. Anchor it there (adhesive tape or safety pin). Close the perineal incision about the tube with interrupted sutures. Apply subsequent dressings held in place by T-bandage.

Comment. The tube from the perineum is removed in about four or five days. Pass sound about that day. Pass urethral sounds early at first every three or four days for about a month, then less often. If only filiform can be passed before the external urethrotomy is done, either Le Fort follower (Fig. [illegible]) or Banks's bougie can be inserted. When it is caught at the point of the stricture, the incision in the urethra is made at this point and the stricture divided along the filiform bougie. The operation is then continued as described above.

External Urethrotomy Without a Guide

Arnott-Wheelhouse's Operation

Arnott was the first to perform this operation in [illegible]. Wheelhouse slightly modified it. This operation is resorted to when even filiform cannot be passed through the stricture. Prepare the patient as in the previous operation.

Step 1. Pass Wheelhouse staff to the point of the stricture. Have an assistant hold the staff firmly and steadily in the median line, the grooved portion facing the skin (Fig. [illegible] a).

Step 2. Make a midline incision in the perineum, opening the urethra on the groove of the staff. Enlarge the opening toward the penis for about two inches. Since the groove does not reach the end of the staff, the incision does not reach the point of the face of the stricture—thus preserving the relation of the stricture to the rest of the urethra.

Step 3. Turn the staff around and withdraw it so that its projection on the end hooks up the upper angle of the wound. Transfix the mucous membrane of the middle of the opened urethra on either side with sutures of silk as shown in the illustration; retract them temporarily to the side; remove the Wheelhouse staff and retract the upper end of the urethra with an ordinary hook (Fig. [illegible] b).

Step 4. Under good illumination the search for the opening in the stricture is now begun. It must be kept in mind that the opening may be in any position on the face of the stricture. The search may be aided by pressure on the hypogastrium forcing some urine through the urethral opening searched for. Note the point of emergence of the urine. Probe even the faintest spot or depression for the opening. If oozing of blood obscures the field, J. W. T. Walker advises a [illegible] sponge be firmly applied until the oozing is under control. Walker further admonishes to use adrenalin with caution.

Step 5. When diligent search is rewarded by finding the opening the rest of the operation is easy. A probe is passed through the stricture, [illegible]

following the probe as a guide and the stricture is completely divided. The incision into the stricture should be longitudinal, exactly in the midline.

Step 6. A gorget or director is passed through the recently divided portion of the urethra, behind the stricture, into the bladder. Pass a large catheter along the penile urethra, guided by the gorget.

Step 7. The perineal wound may be left open without suturing, or the urethra and perineal tissues may be drawn together with a few sutures.

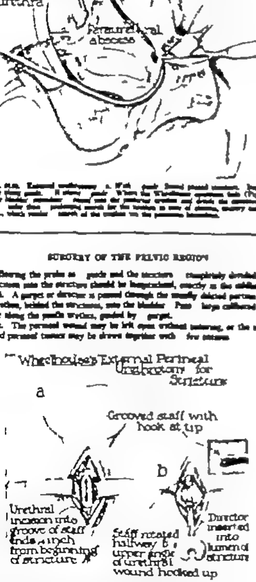

Fig. [illegible] Wheelhouse's external urethrotomy for stricture. [illegible]

Step 8. Anchor the catheter in the urethra. Permit it to remain for 5 or 6 days, then remove. Begin the passage of sounds about a fortnight after the operation.

When the Finding of the Opening Fails. Several methods of procedure are at the disposal of the surgeon.

Method I. If after a diligent search for a reasonable length of time, the opening is not located, do not waste more time and effort and inflict lacerations to the tissues. Endeavor to locate the urethra posterior to the stricture and open it. While cutting, keep strictly to the median line. When the urethra is opened the stricture may readily be divided and a sound be made to readily pass through the stricture, past the perineal wound and into the bladder. The incision in such cases is prolonged rearward over the posterior extremity of the bulb. The bulb

is exposed at its posterior extremity the urethra is easily exposed at its membranous portion (usually dilated here). Pass a probe forward through the stricture and slit the latter from behind forward.

Method II. Open the bladder by a suprapubic cystotomy and attempt retrograde catheterization (passing a metal sound from the bladder toward the front). A Bénique sound (Fig. [illegible] b) is well adapted for the purpose. It [illegible] the perineum posterior to the stricture. Place the patient in the lithotomy position. Incise in the median at the point of the sound. Attempt to pass a probe forward through the opening made and divide the stricture. If this cannot successfully be accomplished, pass a sound through the meatus toward the stricture and divide the scar tissue intervening. Drain through the perineum as described above. Close the suprapubic wound. Irrigate the bladder. Attempt the passage of a sound through the meatus six or seven days after the operation. This often is a very difficult task. [illegible] "more than once found a spur in the depth of the perineal wound which rendered the passage of the sound impossible. Division of the spur was all that was necessary. The spur itself was undoubtedly the result of insufficient division of the stricture at the primary operation." Sounds should be passed as already outlined above.

Urethrectomy

RESECTION—EXCISION OF THE STRICTURE

Historical Notes. The operation dates back to 18[illegible]. It has been popularized by König who in [illegible] successfully removed a stricture of the perineal portion of the urethra. He divided the urethra transversely at each end of the stricture, the intervening scar tissue was excised and the ends of the urethra united by sutures. Since 1891, the method has been widely used by French surgeons (Guyon, Albarran, Pousson, Malaine), in Germany by Walker and in America by Keyes, Cabot, and others.

Indications. Cases of stricture not amenable to other methods of treatment. Traumatic strictures are usually subjected to this form of surgical therapy.

Methods. A Complete division of the urethra in front and behind the stricture, removal of the strictured segment and allowing the intervening urethral gap to heal over an indwelling catheter which is permitted to remain until healing is complete.

B Same, except that the divided ends of the urethra are united by sutures.

C Instead of completely dividing the urethra the roof is permitted to remain. Incomplete urethrectomy is the method usually practised.

Step 1. Pass a probe through the stricture, if possible. Prepare the patient as outlined above. Expose and open the urethra as in external urethrotomy.

Step 2. Dissect the stricture all around its urethral extent, with the exception of a portion of mucous membrane at the roof of the urethra. Every vestige of scar tissue comprising the stricture should be removed by sharp dissection.

Step 3. This consists of restoring the continuity of the urethra. Introduce a retention catheter into the bladder.

Methods of Union of the Urethra. End-to-end union with the urethral catheter in situ. Use fine chromic catgut interrupted sutures which do not include the mucosa. Longitudinal sutures are passed as follows: one on either side to unite the gap at the side walls, one in the median line and one on either side of this (Albarran). (Fig. [illegible])

Step 4. Close the superficial perineal wound with sutures or leave it open to heal by granulation.

After Treatment. The soft rubber catheter is permitted to remain in the bladder for about one week. When it causes irritation it is removed earlier. After the catheter is removed the passage of sounds is commenced gradually.

Comment. Young's procedure consists of opening the urethra in front of the stricture which is found by [illegible] filiform introduced through it. The filiform is withdrawn and [illegible] grooved director is introduced and the stricture divided with [illegible] sharp knife. Excision of the stricture is accomplished by thorough excision of the cicatrized area leaving [illegible] narrow bridge

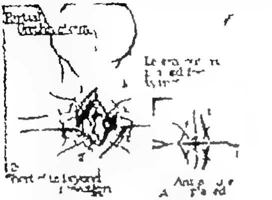

Fig. [illegible]. [illegible] [illegible] of perineal urethrotomy. After the lateral urethral [illegible] [illegible] [illegible] [illegible]

of mucous membrane connecting normal anterior and posterior portions of the urethra. The soft tissues are sutured fairly tight over a large catheter introduced into the bladder through the meatus, closing the defect completely. A second row of catgut sutures reinforces the first. The skin and subcutaneous tissues are closed completely except at the superior angle where [illegible] small drain is inserted. The catheter in the bladder is fastened in place. The bladder is irrigated. The catheter is permitted to remain for about [illegible] week unless suppuration supervenes. Beginning on the twelfth day dilatation with urethral sounds is begun; the procedure is repeated every fourth or fifth day until the desired results are obtained.

[illegible] OPERATION

Rationale. It has been shown that the male urethra can be divided from the [illegible] to the membranous portion and healing will take place without stric-

[illegible]

ture formation, provided that sufficient perineal drainage is instituted during the healing process.

Operation

Step [illegible]. High lithotomy position. An incision with its apex at the central point of the perineum is made. Open the ischiorectal fossae. The central [illegible] sphincter is detached at the central tendon from the bulbocavernosus muscle. Retract the sphincter with [illegible] retractor backward. Expose the membranous urethra and the apex of the prostate by pulling forward the bulb of the urethra and the transverse perineal muscles. Open the membranous urethra longitudinally. Introduce [illegible] silk traction suture on each side of the wound. The urethra is split forward toward the stricture.

Step 2. Introduce a guide or sound through the meatus to the face of the stricture and at that point also divide the urethra longitudinally in front of the stricture in the median line, the incision meeting the apex of the first incision. The urethral wound is also separated by lateral traction sutures. The exposed stricture is visualized and with it the urethra is found behind it and with the stricture split open for an inch or so.

Step 3. The stricture is now excised completely together with its surrounding scar tissue; the removal of the latter must be thorough.

Step 4. The divided ends of the urethra are mobilized by undercutting. They are then united with fine interrupted catgut sutures.

Step 5. A catheter is placed into the bladder through the perineal wound and there anchored with sutures. The lateral perineal wounds are united with deep silkworm gut sutures. No sutures are placed in the perineum in front of the catheter.

Step 6. Remove the catheter from the bladder in about [illegible] week. After healing has taken place (several weeks), sounds (full-sized) should be passed.

REMOVAL OF FOREIGN BODIES FROM THE URETHRA

The technic of removal of foreign bodies from the urethra depends upon the type of foreign body and upon its location. As [illegible] general rule methods should be employed that will not injure the mucous membrane of the urethra. Stones arrested in the urethra on passage may be removed by [illegible] method. This consists of first injecting an anesthetic solution into the urethra. The patient [illegible] asked to urinate, the stream of urine is then suddenly interrupted by compressing the end of the penis. This dilates the urethra and when pressure is removed the stone may be swept out.

Stones May be Removed With an Alligator Forceps

Needles or pins in the urethra may be effectually dislodged and removed as shown in Fig. [illegible]

RUPTURE OF THE URETHRA

Usually ruptures of the urethra occur in its membranous portion. It is of utmost importance to know whether the rupture is complete or incomplete. A minor incomplete rupture of the urethra may heal spontaneously. In more severe injuries, the sooner operation is undertaken to repair the damage, the better.

Catheterization per urethram often leads to trouble (infection, etc.). Suprapubic cystostomy is indicated (p. [illegible]).

Incomplete Rupture

Perineal drainage will often prevent stricture formation in incomplete rupture of the urethra without extravasation of urine.

Step [illegible]. Suprapubic cystostomy (p. [illegible]).

Step 2. Retrograde catheterization.

Step 3. Open the perineum. Search for the ends of the divided urethra. Mobilize them.

Step 4. Suture the mobilized urethral ends by the method described above (p. [illegible], Fig. [illegible]). Use interrupted sutures of chromic catgut. To avoid the sutures from cutting out, [illegible] firm grip of the corpus spongiosum as well as the mucous membrane should be taken. (Hamilton Bailey.)

Fig. [illegible]. [illegible] method of removing [illegible] pin from the urethra.

Step 5. Pack the wound tightly with gauze. Drain. Take the patient down from the lithotomy position. Reinsert [illegible] de Pezzer catheter into the suprapubic wound.

Comment. Fowler position after the operation and sitz catgut are desirable. Begin passage of bougies after fourteen days—gently, gently.

Complete Rupture of the Urethra with Extravasation of Urine

Suprapubic cystostomy.

Retrograde catheterization.

3. Perineal section. Pass [illegible] Coudé catheter from the meatus into the perineal wound. It is then threaded into the posterior urethra guided by the retrograde bougie.

Tie the catheter to the penis.

5. Drain the space of Retzius.

6. Leave the perineum open. Incise the infiltrated areas as described above under extravasation of urine.

OPERATIONS ON THE PENIS

Anatomic Considerations. The penis is composed of three cylindrical masses of erectile tissue—two corpora cavernosa on the dorsal surface and one corpus spongio-

sum on the ventral surface of the organ. The corpora cavernosa are attached posteriorly to the rami of the ischia and pubes and terminate in blunt ends anteriorly. The corpus spongiosum commences at the bulb, at the central point of the perineum posteriorly and ends in the glans penis anteriorly. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

Vessels and Nerves. The superficial dorsal vein [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

Lymphatics of the Penis and Urethra. The superficial lymphatics of the penis accompany the dorsal vein and end in the superficial inguinal nodes. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

PHIMOSIS

The following principal factors come under consideration in the treatment of phimosis:

To remove the constricted prepuce.

b. To leave the preputial orifice sufficiently large to permit an easy retraction over the glans penis.

To obviate injury to the frenulum.

Anatomic Considerations. It must particularly be remembered that (1) the foreskin (prepuce) [illegible] made up of an outer layer of skin and an inner layer of mucous membrane. These two are separated by [illegible] loose network of connective tissue permitting the skin to freely move over the mucous membrane. A clamp, therefore, placed upon the foreskin as [illegible] practiced in certain operations for phimosis engages only the outer layer of the prepuce while the inner (mucous membrane) escapes. [illegible] incision.

2 The integuments of the prepuce and penis are extremely loosely attached to the underlying structures, while the mucous membrane on the contrary [illegible] firmly attached just behind the corona glandis [illegible] for that reason that the former can be drawn toward the preputial opening with facility. [illegible] [illegible] [illegible] not to pull the foreskin too far forward; the clamp is applied at the point of

of the skin with the inner layer of the mucous membrane; if this is not observed disproportionately large area of skin will be removed compared with the mucous membrane; the skin will retract too far to the root of the penis and difficulty might arise from deficiency of skin to cover the resulting defect. Careful calculation is, therefore, necessary to determine the amount of prepuce to be removed so that upon completion of the operation neither too little nor too much has been taken away.

(3) The looseness of skin may contribute to large hematoma if perfect hemostasis is not obtained.

FOREIGN BODIES AROUND THE PENIS

On occasion the surgeon is called upon to remove metal rings and similar objects from the body of the penis. Some years ago the author had to call a jeweler to saw through a small hammer from which the penis could not be extricated by ordinary means. Under anesthesia the hammer was sawn through, but the penis was much traumatized before being liberated.

John E. Cannaday[1] writes:

"From time to time we hear of cases in which a ring or other closely fitting circular device has been placed around the penis. After a short time so much swelling has taken place that the possessor is unable to remove the ring. Some of these instances, no doubt, are the result of boyish pranks; again this has at times been done with the idea of preventing bed wetting. Other cases occur among those having psychopathic or neurotic tendencies, and in some instances rings or other similar devices have been placed on the male organ by practical jokesters while the victim was in drunken sleep.

FIG. [illegible]. Metal ring removed from swollen penis. (Courtesy of Dr. John E. Cannaday.)

"The portion beyond the ring swells, the skin immediately under the ring becomes eroded, and about this time the patient usually consults a physician. The ring can usually be removed by cutting it in two at one side and spreading the ends apart. Occasionally some hard and highly resistant metal may be encountered, as was the case in the subjoined report.

Case Report. E. M., aged fifteen years, of St. Albans, W. Va., was admitted to the Charleston General Hospital in a very uncomfortable condition. He gave a history of slipping a bicycle cone over his penis two weeks before admission to the hospital. He was unable to remove it and was ashamed to tell anyone about it. Finally he became so disabled that he told his mother who called a physician, Dr. T. S. Tompkins, who sent him to the hospital.

"On examination he showed an enormous swelling of the penis; the skin was very badly eroded all around the circumference due to the pressure of the ring.

"It is well known that the cones and other of the wearing parts of bicycles are usually made of vanadium or chrome steel, either one of which is of extreme hardness and is cut with great difficulty. Numerous ineffectual attempts were made to divide this piece of metal with a hack saw. Six or so hack saw blades having

[1] Amer. Jour. Surg., [illegible].

been worn out in the course of eleven hours without making any headway at all worth while. It finally was decided that the only possibility of getting off the ring, or cone, was by reversing the manner in which it had been put on.

"Under gas anesthesia, after making multiple punctures in the edematous skin and forcing out the serum, compressing the penis manually and with an Esmarch bandage, we finally succeeded in reducing its size sufficiently to enable us gradually to force it back through the opening in the cone by grasping a portion of the body with a sponge forceps and gradually working it back through the opening. The penis was considerably traumatized in the process but after a few days was apparently restored to normal (Fig. [illegible]).

FIG. [illegible]. A. [illegible] of the glans penis—the result of an auto accident. B. The two halves of the glans separated showing the [illegible].

"The case is reported merely because the ring could not be removed in the usual manner by dividing and spreading it and to describe a different method of removal of the ring from that usually practiced in such cases."

INJURIES TO THE PENIS

Injuries to the penis may be manifold and may be occasioned by a variety of factors. Figure [illegible] shows a complete bisection of the glans penis. The patient was run over by an automobile and the wheel passed over his pubic region resulting in considerable damage besides bisecting the head of the penis. The pictures shown here were taken 20 years after the accident. The urinary meatus is shown between the two halves of the glans. The patient did not suffer any ill effects in his vita sexualis by reason of the injury. Erections were perfect and the consummation of the sexual act entirely satisfactory.

CIRCUMCISION

Classical Operation—Postectomy

In the Newborn. Often no anesthetic is required. A sucker consisting of sponge dipped in sweet sugar water will often suffice to calm the baby.

Step 1. Draw back the prepuce. Expose the glans penis. Separate adhesions. Clear away the smegma and debris. If the preputial orifice is too narrow introduce an artery forceps and devulse it.

Step 2. Draw the prepuce forward. Apply to it an appropriate clamp obliquely keeping in mind the points stressed above (see anatomic considerations). Cut away the prepuce in front of the forceps.

Step 3. Remove the clamp. Introduce a pair of delicate scissors between the glans penis and the mucous membrane. Be careful not to introduce the scissors into the urethra. Trim away the excess mucous membrane.

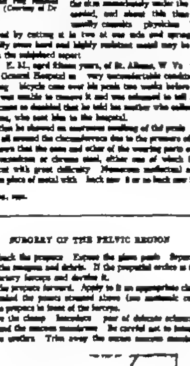

FIG. [illegible]. Infiltrating the prepuce and frenum [illegible]. Postectomy.

Step 4. Often no sutures are needed. If bleeding points are active at the frenum, ligate them.

In the Adolescent and Adult. Prepare the parts carefully by scrubbing with soap and water followed by a nonirritating antiseptic fluid (zephiran, mercurochrome, etc.). Note carefully the position of the corona glandis beneath the skin of the penis while the organ is flaccid; grasp the glans penis, pull it strongly forward and note the position of the corona glandis in its relation to the skin of the shaft of the penis and prepuce, thus obtaining an idea of how much of the prepuce is to be removed to obtain the best possible results. Always err on the side of safety; remove rather too little than too much of the prepuce.

Anesthesia. Infiltration or general anesthesia (Fig. [illegible]). If the former is used, apply a constrictor at the root (base) of the penis. Infiltrate the base of the proposed incision with [illegible] per cent novocaine solution. Deposit the anesthetic fluid in the skin and beneath the mucous layer of the foreskin. Fill the pre-

putial sac with a 4 per cent solution of novocaine and permit it to remain for about five minutes. General anesthesia may be used when indicated. In the neurotic or excessively apprehensive patient evipal or nitrous-oxide-oxygen anesthesia may be used to advantage.

Step 1. Engage the prepuce with an artery forceps in the midline at the junction of the skin and mucous membrane. Sweep a grooved director beneath the prepuce over the head of the penis, thus breaking up any adhesions present. Again note the position of the corona glandis and apply an artery clamp extending obliquely forward from the glans to the ventral surface as shown in the illustration (Fig. [illegible], upper). Do not include the attachment of the frenum to the glans, in the artery forceps.

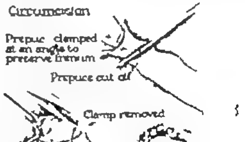

FIG. [illegible]. Steps in the operation of circumcision. (Study in connection with text.)

Step 2. Cut away the prepuce by an incision which passes just above and close to the upper margin of the clamping forceps. Remove the clamp.

Step 3. Pass one blade of the scissors between the glans penis and the inner layer of the mucous membrane (Fig. [illegible], middle); do not inadvertently enter the urethra; divide the mucous membrane as far back as the margin of the corona glandis. Turn back the cuff of mucous membrane. Trim away the mucosa to a desirable degree (not too short).

Step 4. If there is any bleeding, arrest it promptly and thoroughly with ligatures. Remove the constrictor from the penis. Unite the edges of the mucous membrane to the integumental border with interrupted catgut sutures or

Pagenstecher linen sutures. Use as many sutures as are necessary to complete coaptation (Fig. [illegible], lower).

Step 5. Dress. It is wise to keep the patient in bed for a day or two.

Comment. Many methods for circumcision have been devised; it is best to thoroughly master one standard method than to know many incompletely. If absent results, pressure and minute punctures with a needle will control it. Do not trim off the mucous membrane too close to the corona glandis. In patients who have undergone previously an unsuccessful circumcision operation, the problem is to free the glans penis from adhesions and bring the structures into normal relationship.

Dorsal-Slit Operation

This operation is practiced in inflammatory conditions, ulcerations, etc., when the classical posthectomy is contraindicated (chancre, chancroid, impossibility of retracting the glans penis, etc.).

Infiltration anesthesia along the line of incision is effective. The anesthetic fluid is introduced into the skin of the prepuce and just beneath the mucous surface.

Step 1. Whenever possible insert a grooved director into the preputial cavity.

Step 2. Incise the prepuce along the director. If a director cannot be introduced, incision without injury to the corona glandis is done to expose the affected parts.

Step 3. Retract the lips of the wound, expose the lesions present and treat them according to conditions present (chancre or electrocauterization, curettement, curettage, etc.). Establish free exposure and drainage. The line of incision should be kept free from infection. If the margins appear healthy after resection of redundancies, they may be loosely approximated with catgut sutures.

Beware of introducing the director or scalpel into the urethra.

PARAPHIMOSIS

Treatment may be (a) manipulative or (b) operative. If the former, it is endeavored to push back the glans and manipulate the prepuce forward. If the latter is successfully brought down, prompt circumcision should be considered, to avoid recurrence.

The nonoperative treatment of paraphimosis (Fig. [illegible]) is described by Keyes as follows: "Squeeze the penis behind the constricted prepuce in the fork of the index and middle fingers of both hands, one placed on each side. Now make pressure with the thumbs on both sides in such a direction as to compress the glans laterally rather than from before backward, and at the same time pull the stricture portion of the prepuce forward, the object being rather to pull the stricture over the glans than to push the glans through the stricture." If these methods fail, operation must be resorted to.

Step 1. Grasp the tip of the glans penis with the left hand and draw it down in such a manner as to arch the dorsal surface upward.

Step 2. Pass the point of a curved bistoury through the mucous membrane, just

anterior to the constricting ring, a little to the side of the median line in order to avoid injury to the dorsal vein of the penis. The point of the knife is pushed through the constriction which is completely divided (Fig. [illegible]).

Step 3. Draw the prepuce down over the glans.

AMPUTATION OF THE PENIS

This may be (a) partial or (b) complete. The former is usually performed in crushing injuries and certain limited lesions; the latter in malignancies (Fig. [illegible]). Before resorting to amputation be sure of your diagnostic grounds; serious mistakes have been made in both directions.

Fig. [illegible]. Paraphimosis.

Partial Amputation

Step 1. Apply an elastic constrictor to the root of the penis (Fig. [illegible]). Carry a circular incision around the penis about three-fourths of an inch distant from the disease, dividing the tissues down to the fibrous sheath of the corpora cavernosa. Retract the skin.

Step 2. Expose and ligate the dorsal vessels of the penis.

Step 3. Divide the corpora cavernosa transversely down to the corpus spongiosum.

Fig. [illegible]. Operation for paraphimosis. Showing the curved bistoury introduced under the constricting ring to one side of the median line.

Step 4. Carefully dissect the corpus spongiosum from the inferior surface of the cavernous bodies. Divide the corpus spongiosum and urethra about a quarter of an inch in front of the line of incision through the corpora cavernosa.

Step 5. Four or more catgut sutures are passed transversely across the divided surface of the corpora cavernosa (Fig. [illegible] b), passing the encircling fibrous

sheath on either side and through the septum, situated between the two organs. After the placement of the sutures is accomplished, tie the sutures (Fig. [illegible] c) thus compressing the blood spaces and securing hemostasis.

Step 6. Remove the constrictor. Make an incision in the median line of the skin flap (ventrally). Make a corresponding cut in the urethra in the midline above and below. Bring the edges of the circular part of the skin flaps to the edges of the urethral orifice. The edges of the circular skin flaps are adapted to the margins of the urethra with interrupted fine Pagenstecher linen sutures (Fig. [illegible] d).

Step 7. Insert a catheter into the bladder. Dress the wound.

Fig. [illegible]. Carcinoma of penis.

NICOLL'S MODIFICATION

In addition to the above, Nicoll suggests the following additional steps:

Step 1. An incision is made over each inguinal region uniting the incisions then made in the middle at the root of the penis and from that point of junction continue the incision along the mid-dorsal line of the penis to the place chosen for amputation.

Step 2. The lymph nodes of both inguinal regions are dissected free from above downward and from without inward including those on the dorsum of the penis. This should be a block dissection. Proceed with the amputation as outlined above.

EXTIRPATION OF THE PENIS

A block dissection of the penis and its lymph apparatus is the object of this operation. The principle of the operation is akin to block removal of the breast and the axillary lymph nodes. There is no need to sacrifice so important functional structures as the testes since their blood and lymph supply is entirely distinct from that of the penis.

Step 1. The patient is placed in the dorsal position. An incision is made be-

ginning at the spine of the ilium on each side running parallel with Poupart's ligament about a finger breadth above it and carried to the median line

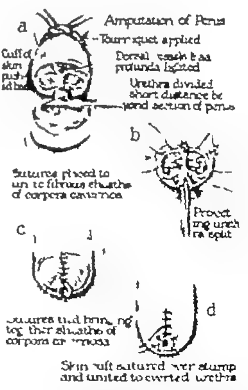

Fig. [illegible]. Amputation of the penis. a, Tourniquet. Circular incision. Ligation of dorsal vessels of penis. Division of corpora cavernosa down to corpus spongiosum. Dissection of corpus spongiosum and division of urethra a short distance beyond section of penis. b, Suturing of [illegible] sheaths and placement of sutures. c, Sutures tied compressing corpora cavernosa thus aiding hemostasis. d, Suturing of cuff over stump of penis to everted urethra.

above the base of the penis. Young adds two longitudinal incisions on each side of the base of the penis to the point of amputation.

Step 2. Deepen the incision to the aponeurosis of the external oblique muscle; dissect out completely the chain of lymph nodes en masse with the superimposed subcutaneous tissues, working from above downward and inside in such manner that the block of tissue removed will, when completed, embrace the portion of the penis to be ablated. Strip the tissues overlying the spermatic cords cleanly. On reaching the femoral regions the dissection extends to the thigh disengaging the lymph nodes of these regions and carrying the dissection into the upper part of the scrotum. "The saphenous and superficial epigastric veins," says Young, "should be sacrificed, the cribriform fascia incised, and the deep group of femoral nodes dissected away cleanly from the artery and vein. This is necessary because some channels from the glans run directly to the deep group of the lymph nodes."

Step 3. It is usually necessary to divide the penis at its base and excise the bulb and corpora cavernosa. Divide the suspensory ligament of the penis. Dissect from above downward to the point where the corpora cavernosa are to be divided. Divide these transversely after first applying a rubber constrictor to the upper segment of the remaining stump.

Step 4. Treat the corpora cavernosa, the corpus spongiosum and the urethra as outlined above in partial removal of the penis. (Steps 4, 5, 6 and 7 above.)

Total Extirpation of the Penis—Dávalos' Technic

Alexander J. Dávalos of Paraguay described the following surgical technic:

Step 1. Skin Incision. The patient is placed on the back with hips elevated by a cushion. The testis are prepared and fixed upon the abdomen. Make an incision through the skin of the perineoscrotal raphé about 8 cm. in length ending about 3 cm. in front of the anus (Fig. 2141).

Step 2. Isolation of the Corpora Cavernosa and the Urethra. After the urethra has been exposed, isolate the corpora cavernosa from the contiguous structures by a grooved director and hold the parts with a Farabeuf retractor (Fig. 2142).

Step 3. Dissection and Division of the Urethra. The urethra is dissected free and detached from the corpora cavernosa for about 3 or 4 cm. Divide it transversely (Fig. 2143). During the dissection of the urethra one must proceed through the proper line of cleavage and to keep away as much as possible from the corpora cavernosa. Loss of blood is thus avoided.

Step 4. Division of the Corpora Cavernosa. After the urethra has been divided, displace it laterally or downward. Divide transversely the corpora cavernosa as near as possible to their ischiopubic insertions. Clamp the dorsal vessels of the penis with artery forceps and while an assistant compresses the proximal end of the corpora cavernosa, place a clamp on their distal ends. This reduces bleeding considerably (Fig. 2144).

Step 5. Suture of the Corpora Cavernosa. The ends of the corpora cavernosa are sutured with interrupted catgut sutures. Ligate the dorsal vessels of the penis (Fig. 2145).

Step 6. Completion of Extirpation of the Penis. Make an incision into the skin encircling the root of the penis. Prolong this incision on both sides laterally over the scrotum, the lateral incisions joining the ends of those

Prensa Med Argentina, de Med. y de Cir., T. No. 10, Dec. 1930.

Fig. 2141. Fig. 2142.
Fig. 2141. Incision along the perineal raphé.
Fig. 2142. Isolation of the corpora cavernosa and of the urethra.

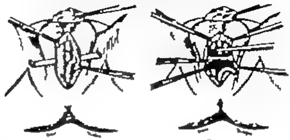

Fig. 2143. Fig. 2144.
Fig. 2143. Dissection and division of the urethra.
Fig. 2144. Division of the corpora cavernosa.

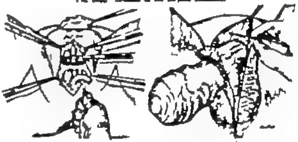

Fig. 2145. Fig. 2146.
Fig. 2145. Suture of the corpora cavernosa.
Fig. 2146. Freeing of the corpora cavernosa and of a portion of the scrotum, from above downward. (Courtesy, Dr. A. J. Dávalos.)

made on the median raphé. Endeavor to remove as much as possible of the scrotum. Divide above and below the suspensory ligament of the penis and the attachments of the corpora cavernosa. When the inferior surface is reached, the penis together with a portion of the scrotum are removed en block (Fig. 2146).

Step 7. Suture of the Scrotum. Begin at the pubic end and close the lips of the wound of the scrotum by interrupted silk sutures. Continue in the fashion indicated in Fig. 2147.

Step 8. Implantation of the Urethra into the Perineum. Split the urethra for about 1 cm. on its lower surface, and suture it to the skin of the perineum.

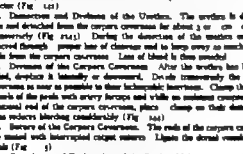

Fig. 2147. Fig. 2148.
Fig. 2147. Scrotum sutured: anterior view of the peno-scrotal region.
Fig. 2148. View of the perineo-scrotal region. The central end of the urethra is sutured to the perineum.
(Courtesy of Dr. A. J. Dávalos.)

Pass a retention catheter into the urethra and permit it to remain there during the time of healing—approximately 8 to 10 days (Fig. 2148).

Comment. After the operation is completed and the scrotum united properly it will give the appearance of a penis. It is for that reason that sufficient tissue from the scrotum should be removed. It will be noted that after cicatrization has taken place and the catheter removed, the patient will urinate standing without wetting the scrotum. This together with the appearance of the newly shaped scrotum will tend to alleviate the mental suffering of these patients.

Most surgeons object to complete emasculation, a procedure Roberto Alessandri of Rome strongly advocates. Young comments on this question as follows: "In our experience, patients object seriously to such mutilation since some of them are able to have fairly satisfactory coitus after even very extensive resections of the penis."

The thought is comforting that carcinoma of the penis is usually of slow growth. (Barlow.) Amputation at the junction of the middle and distal thirds or at the middle of the penis does not necessarily interfere with the "potentia coeundi" nor with the "potentia generandi."

PLASTIC OPERATION ON THE PENIS

Hypospadias

This consists of an abnormal opening on the inferior wall of the urethra. If situated on the glans penis it is spoken of as balanic. If on the shaft, penile; or, it may be scrotal or perineal in location. Often some deformity exists which should be remedied before repair of the defect is undertaken. Fortunately the abnormal opening in the vast majority of cases of hypospadias is located at the glans penis or immediately below it. These require no surgical intervention. It is different in cases of penile, scrotal or perineal hypospadias, which should be subjected to painstaking surgical repair.

Perineal urethrostomy or suprapubic cystostomy as a preliminary is not only advisable but often essential to success. Young advocates the procedure warmly. The Young-Shaw apparatus enables one to obtain continuous, efficient bladder drainage at the same time keeping the bladder bathed in an antiseptic solution, thus, to frustrate infection.

Perineal Urethrostomy. By this procedure the retention catheter and its evil influences (urethritis, cystitis, etc.) are avoided. The operation consists of cutting an opening in the perineum leading to the bladder. Incisions sufficiently long are made in the skin and urethra which, when united by sutures, form a mucocutaneous fistula for diverting the urine. The opening is maintained in service until desired results are obtained. "Until recently," Young says, "almost all hypospadias cases which had been drained through a perineal retention catheter have become infected."

VON HACKER-BECK OPERATION

Von Hacker of Germany and Carl Beck of New York popularized this operation which is useful in glandular and anterior penile hypospadias.

The method consists essentially of mobilizing the meatus and anterior portion of the urethra, tunneling the glans penis and advancing the urethra through this tunnel (Figs. 2149–2150–2151–2152). A cuff of skin surrounding the meatus urinarius is carefully preserved. The tunnel is made with a sharp, slender bistoury; the meatus and its tegumentary cuff is brought to the surface of the glans and then sutured in place with Pagenstecher celluloid linen. Young prefers the Duplay operation to this procedure, stating that the curve of the penis already existing is accentuated by this operation.

DUPLAY'S OPERATION FOR GLANDULAR HYPOSPADIAS

This operation is well adapted to cases in which there is a groove on the under surface of the glans representing the glandular urethra. The edges of this groove are freshened and brought together in the midline over a retention catheter by interrupted sutures of fine silk or chromic catgut. When the flaps are too short to come together without undue tension, lateral incisions into the tissues of the glans penis are made which will overcome this difficulty. The retention catheter is retained until complete healing takes place.

Comment. Many procedures have been devised and modified for the treatment of hypospadias. There is no procedure which will suit every

condition. Internal urethrotomy is necessary before attempting to repair the urethral defect. As already stated, the curvature of the penis must be corrected. The organ is often held down to the scrotum; it must be freed first by transverse incisions which are sutured in a vertical line. The penis must be retained in an extended position while the wounds heal. About six months should elapse before an attempt is made to repair the urethral defect. Do cystostomy.

Fig. [illegible] Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible] [illegible] (New York) operation for balanitic hypospadias. [illegible]

Fig. [illegible] [illegible]

Fig. [illegible] [illegible]

Fig. [illegible] [illegible]

Epispadias

The deformity here is on the dorsal surface of the penis. It is rare as compared with hypospadias. It usually is accompanied by deformities of the anterior wall of the bladder, the sphincters of the bladder and urethra as well as the symphysis pubis. Little can be gained in these cases by a plastic operation on the urethral defect alone. In these cases the deformity of the penis is corrected first, preceded by [illegible] urethrotomy.

Operations for Epispadias. As stated, the surgical treatment of epispadias is difficult and tedious, requiring time, patience and skill. The preliminary steps as in the surgical treatment of hypospadias are

1. Urethrotomy.
   Redressment of the penis.

the latter, after any existing dermatitis has cleared up. (Division of constricting bands, splitting the penis, etc.)

THIERSCH'S OPERATION [illegible]

This operation can be carried out only when the urethral sulcus is deep enough to permit the reconstruction of a canal of proper caliber. Two parallel areas are denuded on each side of the urethral sulcus, from the fore of the glans penis to the margin of the epispadiac opening and these two areas are united with sutures over [illegible] catheter placed in the sulcus (Figs. [illegible]). After healing of the wounds, the posterior extremity of the new canal thus formed is united by sutures to the margin of the epispadiac opening. To complete the suture the prepuce may be used.

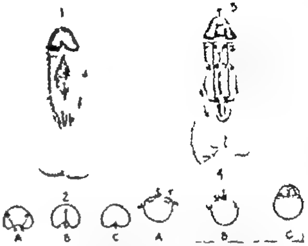

Fig. [illegible] Fig. [illegible]

Fig. [illegible] [illegible] operation for hypospadias. [illegible] A. [illegible] B. [illegible] C. [illegible]

Fig. [illegible] [illegible] operation for hypospadias. [illegible] A. [illegible] flaps X and Y [illegible] B. [illegible] flaps X and Y [illegible] C. [illegible] flaps X and Y [illegible]

[illegible] OPERATION

In this operation, the new urethra is constructed of flaps secured from the penis, prepuce and pubic region.

Step 1. Two rectangular flaps are fashioned on each side of the urethral gutter. One flap is made by [illegible] longitudinal incision upon the summit of the margin of the urethral furrow running parallel with the furrow for its entire extent. Carry an incision at right angles from each extremity of the incision just described out over the side of the penis. Dissect up this flap, which is to become the external surface of the canal formed by the next flap. The base of the flap lies along the outer aspect of the penis (Fig. [illegible]).

Step 2. The second flap is fashioned by making two transverse incisions from the anterior and posterior extremities of the other side of the urethral furrow outward over that side of the penis for [illegible] distance of one centimeter, or more and the extremities of these transverse incisions are connected by an incision which lies upon the other side of the penis running parallel with its axis. This flap is dissected out so that its base rests along the margin of the urethral furrow and it is turned over the furrow so that its skin surface forms the roof of the new urethra and its raw surface is exposed over the new channel.

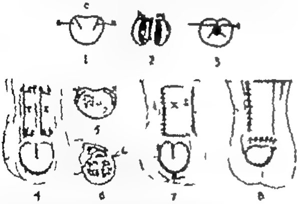

Fig. [illegible] [illegible] operation for Epispadias. [illegible]

Step 3. Suture the longitudinal margin of this flap along the line of the base of the first flap, the sutures passing through the first flap at its base line.

Step 4. Draw Flap No. [illegible] over the newly constructed urethra. Suture its longitudinal margin to the corresponding margin at the outer limit of the denuded area on the opposite side of the penis.

Wait until complete healing has taken place.

Step 5. Two orifices remain to be closed now: an anterior (the meatus) and posterior (epispadias). The former is closed by a plastic procedure consisting of utilizing the prepuce. Make a transverse incision through a part of the width of the prepuce. Pass the glans through this opening. The prepuce is now united by its incised margin, which has been passed onto the dorsum of the penis, to the freshened edge of the anterior ends of the flaps made at the time of the first operation.

Closure of the posterior opening is accomplished by flaps taken from in front of the pubis, one turned down to be sutured to the posterior end of the canal and second flap turned down to cover the raw surface of the first.

[illegible] OPERATION

Step 1. Lift a rectangular flap from the under-surface of the penis below the urethral orifice (Fig. [illegible]).

Step 2. Turn the flap up over the catheter which has been placed in the groove of the glans so that the skin surface faces the interior forming the wall of the new urethra (Fig. [illegible]).

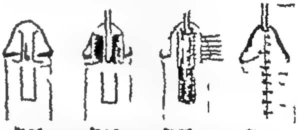

Fig. [illegible] Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible] [illegible] operation for balanitic hypospadias. [illegible]

Fig. [illegible] [illegible]

Fig. [illegible] [illegible]

Fig. [illegible] Operation completed.

Step 3. Raise [illegible] small lateral flap on either side of the glans and insert the lower, larger flap (Fig. [illegible]).

Step 4. Suture the lateral flaps together so that they form the new urethral opening (Fig. [illegible]).

The above operation is especially adaptable to adults.

Operation for Penile and Perineal Hypospadias

There are many different operations to correct this condition. All of them consist in (a) correcting the curvature of the penis and freeing the latter from its attachments to the scrotum and (b) the formation of [illegible] canal in the penile part of the urethra.

In the formation of [illegible] new penile urethra, it must be remembered that

1. Raw surfaces and not skin edges should be brought together no matter what sort of repair one resorts to.
2. Avoid tension.
3. The circulation of the flaps must not be interfered with.
4. Flaps must be rather over-sized to allow for contraction.
5. Avoidance of infection.
6. In case the operation fails the patient is in no worse condition than before the operation.

condition. Individualization is necessary before attempting to repair the urethral defect. As already stated, the curvature of the penis must be corrected. The organ is often held down to the scrotum; it must be freed first by transverse incisions which are sutured in a vertical line. The penis must be retained in an extended position while the wounds heal. About six months should elapse before an attempt is made to repair the urethral defect. Do cystostomy

Fig. [illegible] Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible] [illegible]

Epispadias

The deformity here is on the dorsal surface of the penis. It is rare as compared with hypospadias. It usually is accompanied by deformities of the anterior wall of the bladder, the sphincters of the bladder and urethra as well as the symphysis pubis. Little can be gained in these cases by plastic operation on the urethral defect alone. In these cases the deformity of the penis is corrected first, preceded by urethrostomy.

Operations for Epispadias. As stated, the surgical treatment of epispadias is difficult and tedious, requiring time, patience and skill. The preliminary steps as in the surgical treatment of hypospadias are:

1. Urethrostomy
   Redressement of the penis.

the latter, after any existing dermatitis has cleared up. (Division of constricting bands; splinting the penis, etc.)

[illegible] OPERATION (URETHROPLASTY)

This operation can be carried out only when the urethral sulcus is deep enough to permit the reconstruction of a canal of proper caliber. Two parallel incisions are

denuded on each side of the urethral sulcus, from the base of the glans penis to the margin of the epispadiac opening and these two areas are sutured with sutures over a catheter placed in the sulcus (Figs. [illegible] 14). After healing of the wounds, the posterior extremity of the new canal thus formed is united by sutures to the margin of the epispadiac opening. To complete the suture the prepuce may be used.

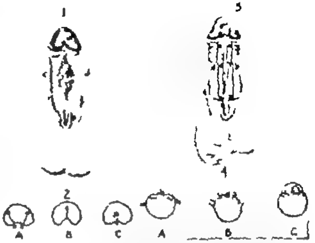

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Duplay's operation for hypospadias. [illegible]

Fig. [illegible] Duplay's operation for hypospadias. [illegible] flaps X and Y [illegible]

THIERSCH'S OPERATION

In this operation the new urethra is constructed of flaps secured from the penis, prepuce and pubic region.

Step 1. Two rectangular flaps are fashioned on each side of the urethral gutter. One flap is made by a longitudinal incision upon the margin of one margin of the urethral furrow, running parallel with the furrow for its entire extent. Carry an incision at right angles from each extremity of the incision just described out over the side of the penis. Dissect up this flap, which is to become the external surface of the canal formed by the next flap. The base of the flap lies along the outer aspect of the penis (Fig. [illegible]).

Step 2. The second flap is fashioned by making two transverse incisions from the anterior and posterior extremities of the other side of the urethral furrow outward over that side of the penis for a distance of one centimeter, or more and the extremities of these transverse incisions are connected by an incision which lies upon the other side of the penis running parallel with its axis. The flap is dissected out so that its base runs along the margin of the urethral furrow and it is turned over the furrow so that its skin surface forms the roof of the new urethra and its raw surface is exposed over the new channel.

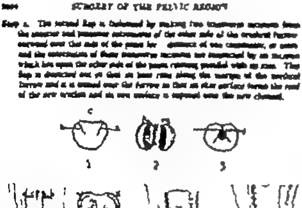

Fig. [illegible] Thiersch operation for Epispadias. [illegible]

Step 3. Suture the longitudinal margin of this flap along the line of the base of the first flap, the sutures passing through the first flap at its base line.

Step 4. Draw Flap No. 1 over the newly constructed urethra. Suture its longitudinal margin to the corresponding margin at the outer base of the denuded area on the opposite side of the penis.

Wait until complete healing has taken place.

Step 5. Two orifices remain to be closed now: an anterior (the meatus) and posterior (epispadias). The former is closed by a plastic procedure consisting of utilizing the prepuce. Make a transverse incision through a part of the width of the prepuce. Pass the glans through this opening. The prepuce is now united by its incised margin, which has been passed onto the dorsum of the penis, to the freshened edge of the anterior ends of the flaps made at the time of the first operation.

Closure of the posterior opening is accomplished by flaps taken from in front of the pubis, one turned down to be sutured to the posterior end of the canal and second flap turned down to cover the raw surface of the first.

[illegible] OPERATION

Step 1. Lift a rectangular flap from the under-surface of the penis below the urethral orifice (Fig. [illegible]).

Step 2. Turn the flap up over the catheter which has been placed in the groove of the glans so that the skin surface forms the internal forming the wall of the new urethra (Fig. [illegible]).

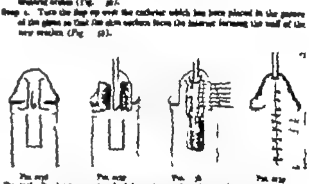

Fig. [illegible] Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible] [illegible] operation for balanic hypospadias. [illegible]

Fig. [illegible] [illegible]

Fig. [illegible] The penile flap [illegible]

Fig. [illegible] Operation completed.

Step 3. Raise a small lateral flap on either side of the glans and insert the lower larger flap (Fig. [illegible]).

Step 4. Suture the lateral flaps together so that they form the new urethral covering (Fig. [illegible]).

The above operation is especially adaptable to adults.

Operations for Penile and Penoscrotal Hypospadias

There are many different operations to correct this condition. All of them consist in (a) correcting the curvature of the penis and freeing the latter from its attachments to the scrotum and (b) the formation of a canal in the penile part of the urethra.

In the formation of a new penile urethra, it must be remembered that:

1. Broad surfaces and not skin edges should be brought together as [illegible]
2. Avoid tension.
3. The circulation of the flaps must not be interfered with.
4. Flaps must be rather oversized to allow for contraction.
5. Avoidance of infection.
6. In case the operation fails the patient is in no worse condition than before the operation.

Step 2. Deepen the incisions to the aponeurosis of the external oblique muscle; dissect out completely the chain of lymph nodes en masse with the suprapubic subcutaneous tissues, working from above downward and inside in such a manner that the block of tissue removed will, when completed, embrace the portion of the penis to be ablated. Strip the tissues overlying the spermatic cords closely. On reaching the femoral regions the dissection extends to the thigh disengaging the lymph nodes of these regions and carrying the dissection into the upper part of the scrotum. "The saphenous and superficial epigastric veins," says Young, "should be sacrificed, the cribriform fascia excised, and the deep group of femoral nodes dissected away closely from the artery and vein. This is necessary because some channels from the glans run directly to the deep group of the lymph nodes."

Step 3. It is usually necessary to divide the penis at its base and excise the bulb and corpora cavernosa. Divide the suspensory ligament of the penis. Dissect from above downward to a point where the corpora cavernosa are to be divided. Divide these transversely after first applying a rubber constrictor to the upper segment of the remaining stump.

Step 4. Treat the corpora cavernosa, the corpus spongiosum and the urethra as outlined above in partial removal of the penis. (Steps 4, 5, 6 and 7 above.)

Total Extirpation of the Penis—Derubes' Technic

Alexander J. Derubes of [illegible] described the following surgical technic:

Step 1. Skin Incision. The patient is placed on the back with legs elevated by [illegible] cushion. The testes are prepared and fixed upon the abdomen. Make an incision through the skin of the perineoscrotal raphé about 8 cm. in length ending about 3 cm. in front of the anus (Fig. [illegible]).

Step 2. Isolation of the Corpora Cavernosa and the Urethra. After the urethra has been exposed, isolate the corpora cavernosa from the contiguous structures by a grooved director and hold the parts with a Farabeuf retractor (Fig. [illegible]).

Step 3. Dissection and Division of the Urethra. The urethra is dissected free and detached from the corpora cavernosa for about 3 or 4 cm. Divide it transversely (Fig. [illegible]). During the dissection of the urethra one must proceed through a proper line of cleavage and to keep away as much as possible from the corpora cavernosa. Loss of blood is thus avoided.

Step 4. Division of the Corpora Cavernosa. After the urethra has been divided, displace it laterally or downward. Divide transversely the corpora cavernosa as near as possible to their ischiopubic insertions. Clamp the dorsal vessels of the penis with artery forceps and while an assistant compresses the proximal end of the corpora cavernosa, place a clamp on their distal ends. This reduces bleeding considerably (Fig. [illegible]).

Step 5. Suture of the Corpora Cavernosa. The ends of the corpora cavernosa are united with interrupted catgut sutures. Ligate the dorsal vessels of the penis (Fig. [illegible]).

Step 6. Completion of Extirpation of the Penis. Make an incision into the skin encircling the root of the penis. Prolong this incision to both sides laterally over the scrotum, the lateral incisions joining the ends of those

[illegible]

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Incision along the perineal raphé.
Fig. [illegible]. Isolation of the corpora cavernosa and of the urethra.

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Dissection and division of the urethra.
Fig. [illegible]. Division of the corpora cavernosa.

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Suture of the corpora cavernosa.
Fig. [illegible]. [illegible] of the corpora cavernosa and of [illegible] portion of the scrotum, from above downward. (Courtesy, Dr. A. J. Derubes.)

made on the median raphé. Endeavor to remove as much as possible of the scrotum. Divide above and below the suspensory ligament of the penis and the attachments of the corpora cavernosa. When the inferior surface is reached, the penis together with a portion of the scrotum are removed en block (Fig. [illegible]).

Step 7. Suture of the Scrotum. Begin at the pubic end and close the lips of the wound of the scrotum by interrupted silk sutures. Continue to the [illegible] indicated in Fig. [illegible].

Step 8. Implantation of the Urethra into the Perineum. Split the urethra for about [illegible] cm. on its lower surface, and suture [illegible] to the skin of the perineum.

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Suture of [illegible] anterior part of the perineal [illegible].
Fig. [illegible]. View of the [illegible] region. The [illegible] end of the urethra [illegible] sutured to the [illegible]
(Courtesy of Dr. [illegible] J. Derubes.)

Place a retention catheter into the urethra and permit it to remain there during the time of healing—approximately 8 to 10 days (Fig. [illegible]).

Comment. After the operation is completed and the sutures united properly, it will give the appearance of a [illegible]. It is for this reason that [illegible] tissue from the scrotum should be removed. It will be noted that after cicatrization has taken place and the catheter removed, the patient will urinate standing without wetting the scrotum. This together with the appearance of the [illegible] shaped scrotum will tend to alleviate the mental suffering of these patients.

Most surgeons object to complete emasculation, a procedure Robert Abbe[illegible] of [illegible] strongly advocates. Young comments on this question as follows: "In our experience, patients object seriously to such mutilation since some of them are able to have fairly satisfactory coitus after even very extensive resections of the penis."

The thought in considering this carcinoma of the penis is usually of slow growth. (Barker.) Amputation at the junction of the middle and distal thirds or at the middle of the penis does not necessarily interfere with the "potentia coeundi" nor with the "potentia generandi."

PLASTIC OPERATION ON THE PENIS

Hypospadias

This consists of an abnormal opening on the inferior wall of the urethra. If situated on the glans penis it is spoken of as balanic; if on the shaft, penile, etc. [illegible] may be scrotal or perineal in location. Other [illegible] deformity exists which should be considered before repair of the defect is undertaken. Fortunately the abnormal opening in the vast majority of cases of hypospadias is located in the glans penis or immediately below it. These require no surgical intervention. It is different in cases of penile, scrotal or perineal hypospadias, which should be subjected to painstaking surgical repair.

Perineal urethrotomy or suprapubic cystotomy as a preliminary is not only advisable but often essential to success. Young advocates the procedure [illegible]. The Young-[illegible] apparatus enables one to obtain continuous, efficient bladder drainage at the same time keeping the bladder bathed in an antiseptic solution, thus, to frustrate infection.

Perineal Urethrostomy. By this procedure the retention catheter and its evil influences (urethritis, cystitis, etc.) are avoided. The operation consists of cutting an opening in the perineum leading to the bladder. Incisions sufficiently long are made in the skin and urethra which, when united by sutures, form [illegible] mucocutaneous fistula for diverting the urine. The opening [illegible] sustained until [illegible] total desired results are obtained. "Until recently," Young says, "almost all hypospadias cases which had been drained through a perineal cystotomy [illegible] have become infected."

THE BECK-HACKER OPERATION

Von Hacker of Germany and Carl Beck of New York popularized this operation which [illegible] useful in glandular and anterior penile hypospadias.

The method consists essentially of mobilizing the meatus and anterior portion of the urethra, tunneling the glans penis and advancing the urethra through this tunnel (Figs. [illegible]). A disc of skin surrounding the urethral meatus is carefully preserved. The tunnel [illegible] made with a sharp, slender, bistoury; the meatus and its appertaining [illegible] is brought to the surface of the glans and then sutured in place with [illegible] [illegible]. Young prefers the Duplay operation to this procedure, stating that the curve of the penis already existing is accentuated by this operation.

DUPLAY OPERATION FOR GLANDULAR HYPOSPADIAS

This operation [illegible] well adapted to cases in which there is a groove on the under surface of the glans representing the glandular urethra. The edges of the groove are freshened and brought together in the median [illegible] [illegible] catheter by interrupted sutures of fine silk or chromic catgut. When the flaps are too short to come together without undue tension, lateral incisions into the corona of the glans penis are made which will overcome this difficulty. The retention catheter [illegible] retained until complete healing takes place.

Comment. Many procedures have been devised and modified for the treatment of hypospadias. There is no procedure which will suit every

[illegible]. Individualization is necessary before attempting to repair the urethral defect. As already stated, the curvature of the penis must be corrected. The organ is often held down to the scrotum; it must be freed first by transverse incisions which are sutured in vertical lines. The penis must be retained in an extended position while the wounds heal. About six months should elapse before an attempt is made to repair the urethral defect. Do [illegible] cystostomy.

Fig. [illegible] Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Carl Beck (New York) operation for balanic hypospadias. [illegible]

Fig. [illegible]. [illegible]

Fig. [illegible]. [illegible]

Fig. [illegible]. [illegible]

Epispadias

The deformity here is on the dorsal surface of the penis. It is rare as compared with hypospadias. It usually is accompanied by exstrophy of the anterior wall of the bladder, the sphincters of the bladder and urethra as well as the symphysis pubis. Little can be gained in these cases by plastic operation on the urethral defect alone. In these cases, the deformity of the penis is corrected first, preceded by [illegible] urethrostomy.

Operations for Epispadias. As stated, the surgical treatment of epispadias is difficult and tedious, requiring care, patience and skill. The preliminary steps as in the surgical treatment of hypospadias are:

Urethrostomy.

2. Redressement of the penis.

the latter after any existing dermatitis has cleared up. (Division of constricting bands; splinting the penis, etc.)

[illegible] OPERATION ([illegible])

This operation can be carried out only when the urethral sulcus is deep enough to permit the reconstruction of a canal of proper caliber. Two parallel areas are

denuded on each side of the urethral sulcus, from the face of the glans penis to the margin of the epispadiac opening and these two areas are united with sutures over a catheter placed in the sulcus (Figs. [illegible]). After healing of the wounds, the posterior extremity of the new canal thus formed is united by sutures to the margin of the epispadiac opening. To complete the suture the prepuce may be used.

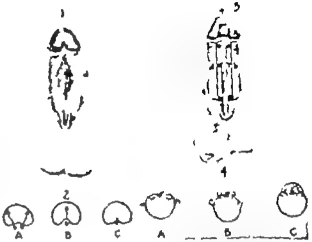

Fig. [illegible] Fig. [illegible]

Fig. [illegible]. Duplay operation for epispadias. [illegible]

Fig. [illegible]. Duplay operation for epispadias. [illegible]

[illegible] OPERATION

In this operation the new urethra is constructed of flaps secured from the penis, prepuce and pubic region.

Step 1. Two rectangular flaps are fashioned on each side of the urethral gutter. One flap is made by a longitudinal incision upon the summit of one margin of the urethral furrow, running parallel with the furrow for an entire extent. Carry an incision at right angles from each extremity of the incision just described out over the side of the penis. Dissect up this flap, which is to become the internal surface of the canal formed by the next flap. The base of the flap lies along the outer aspect of the penis (Fig. [illegible]).

Step 2. The second flap is fashioned by making two transverse incisions from the anterior and posterior extremities of the other side of the urethral furrow, extended over the side of the penis for a distance of one centimeter, or more, and the extremities of these transverse incisions are connected by an incision which lies upon the other side of the penis running parallel with its axis. The flap is dissected out so that its base runs along the margin of the urethral furrow and it is turned over the furrow so that its skin surface forms the roof of the new urethra and its raw surface is exposed over the new channel.

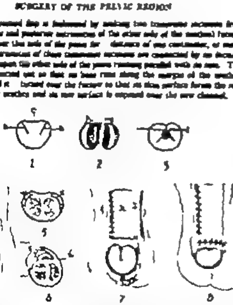

Fig. [illegible]. Thiersch operation for Epispadias. [illegible]

Step 3. Suture the longitudinal margin of this flap along the line of the base of the first flap, the sutures passing through the first flap at its base line.

Step 4. Draw Flap No. [illegible] over the newly constructed urethra. Suture its longitudinal margin to the corresponding margin at the outer limit of the denuded area on the opposite side of the penis.

Wait until complete healing has taken place.

Step 5. Two orifices remain to be closed now: an anterior (the meatus) and posterior (epispadiac). The former is closed by a plastic procedure consisting of utilizing the prepuce. Make a transverse incision through a part of the width of the prepuce. Pass the glans through this opening. The prepuce is now sutured by its incised margin, which has been passed over the dorsum of the penis, to the freshened edge of the anterior ends of the flaps made at the time of the first operation.

Closure of the posterior opening is accomplished by flaps taken from in front of the pubes, one turned down to be sutured to the posterior end of the canal and a second flap turned down to cover the raw surface of the first.

[illegible] OPERATION

Step 1. Lift a rectangular flap from the under-surface of the penis below the urethral orifice (Fig. [illegible]).

Step 2. Turn the flap up over the catheter which has been placed in the groove of the glans so that the skin surface faces the interior forming the wall of the new urethra (Fig. [illegible]).

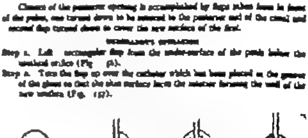

Fig. [illegible] Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible]. [illegible] operation for balanic hypospadias. [illegible]

Fig. [illegible]. [illegible]

Fig. [illegible]. [illegible]

Fig. [illegible]. Operation completed.

Step 3. Raise a small lateral flap on either side of the glans and insert the lower, larger, flap (Fig. [illegible]).

Step 4. Suture the lateral flaps together so that they form the new urethral covering (Fig. [illegible]).

The above operation is especially adaptable to adults.

Operation for Penile and Perineal Hypospadias

There are many different operations to correct this condition; all of these consist in (a) correcting the curvature of the penis and freeing the latter from its attachments to the scrotum and (b) the formation of a canal in the penile part of the urethra.

In the formation of a new penile urethra, it must be remembered that:

1. Broad surfaces and not thin edges should be brought together no matter what sort of repair one resorts to.

2. Avoid tension.

3. The circulation of the flaps must not be interfered with.

4. Flaps must be rather over-sized to allow for contraction.

5. Avoidance of infection.

6. In case the operation fails the patient is in no worse condition than before the operation.

Step 2. Deepen the incision to the aponeurosis of the external oblique muscle; dissect out completely the chain of lymph nodes en masse with the superimposed subcutaneous tissue, working from above downward and inside in such manner that the block of tissue removed will, when completed, embrace the portion of the penis to be ablated. Strip the tissues overlying the spermatic cords cleanly. On reaching the femoral regions the dissection extends to the thigh disengaging the lymph nodes of these regions and carrying the dissection into the upper part of the scrotum. The saphenous and superficial epigastric veins, says Young, should be sacrificed, the cribriform fascia incised, and the deep group of femoral nodes dissected away cleanly from the artery and vein. This is necessary because some channels from the glans run directly to the deep group of the lymph nodes.

Step 3. It [illegible] usually necessary to divide the penis at its base and sever the bulb and corpora cavernosa. Divide the suspensory ligament of the penis. Dissect from above downward to [illegible] point where the corpora cavernosa are to be divided. Divide them transversely after first applying [illegible] rubber constrictor to the upper segment of the remaining stump.

Step 4. Treat the corpora cavernosa, the corpus spongiosum and the urethra as outlined above in partial removal of the penis. (Steps 4, 5, 6 and 7 above.)

Total Extirpation of the Penis—Dimitza's Technic

Alexander J. Dimitza of Paraguay described the following surgical technic.

Step 1. Skin Incision. The patient is placed on the back with legs elevated by [illegible] cushion. The testis are prepared and fixed upon the abdomen. *Make an incision through the skin of the perineum (raphe) about 8 cm. in length ending about 3 cm. in front of the anus* (Fig. [illegible]).

Step 2. Isolation of the Corpora Cavernosa and the Urethra. After the urethra has been exposed, isolate the corpora cavernosa from the contiguous structures by a grooved director and hold the parts with [illegible] Farabeuf retractor (Fig. [illegible]).

Step 3. Dissection and Division of the Urethra. The urethra is dissected free and detached from the corpora cavernosa for about 3 or [illegible] cm. [illegible] divide it transversely (Fig. [illegible]). During the dissection of the urethra one must proceed through [illegible] proper line of cleavage and to keep away as much as possible from the corpora cavernosa. Loss of blood is thus avoided.

Step 4. Division of the Corpora Cavernosa. After the urethra has been divided, displace it laterally or downward. Divide transversely the corpora cavernosa as near as possible to their ischiopubic insertions. Clamp the dorsal vessels of the penis with artery forceps and [illegible] to an assistant. [illegible] the proximal end of the corpora cavernosa, place [illegible] clamp on their distal ends. This reduces bleeding considerably (Fig. [illegible]).

Step 5. Suture of the Corpora Cavernosa. The ends of the corpora cavernosa are sutured with interrupted catgut sutures. Ligate the dorsal vessels of the penis (Fig. [illegible]).

Step 6. Completion of Extirpation of the Penis. Make an incision into the skin encircling the root of the penis. Prolong this incision on both sides laterally over the scrotum, the lateral incisions joining the ends of those

[illegible]

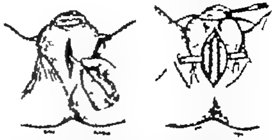

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Incision along the perineal raphe.

Fig. [illegible] Isolation of the corpora cavernosa and of the urethra.

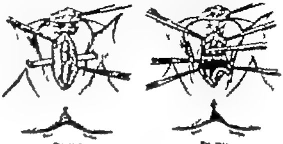

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Dissection and division of the urethra.

Fig. [illegible] Division of the corpora cavernosa.

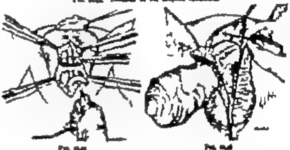

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Suture of the corpora cavernosa.

Fig. [illegible] Freeing of the corpora cavernosa and of [illegible] portion of the scrotum, from above, downward. (Courtesy, Dr. A. J. Dimitza.)

made on the median raphe. Endeavor to remove as much as possible of the scrotum. Divide above and below the suspensory ligament of the penis and the attachments of the corpora cavernosa. When the inferior surface is reached, the penis together with [illegible] portion of the scrotum are removed en block (Fig. [illegible]).

Step 7. Suture of the Scrotum. Begin at the pubic end and close the lips of the wound of the scrotum by interrupted silk sutures. Continue in the fashion indicated in Fig. [illegible].

Step 8. *Implantation of the Urethra Into the Perineum.* Split the urethra for about [illegible] cm., on its lower surface, and suture [illegible] to the skin of the perineum.

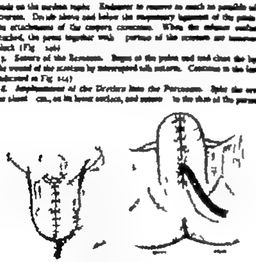

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Sutures entered, anterior view of the [illegible] aspects.

Fig. [illegible] View of the [illegible] aspect. The central end of the urethra [illegible] sutured to the perineum.

(Courtesy of Dr. [illegible] J. Dimitza.)

Place [illegible] retention catheter into the urethra and permit [illegible] to remain there during the time of healing—approximately 8 to 10 days (Fig. [illegible]).

Comment. After the operation is completed and the scrotum sutured properly, it will give the appearance of [illegible] penis. [illegible] is for that reason that sufficient tissue from the scrotum should be removed. [illegible] will be noted that after cicatrization has taken place and the catheter removed, the patient will urinate standing without wetting the scrotum. This together with the appearance of the nicely shaped scrotum will tend to alleviate the mental suffering of these patients.

Most surgeons object to complete emasculation, [illegible] procedure Robert Abbe [illegible] of Rome strongly advocates. Young comments on that question as follows: "In our experience, patients object strenuously to such mutilations since some of them are able to have fairly satisfactory coitus after even very extensive resections of the penis."

The thought is comforting that carcinoma of the penis is usually of slow growth. (Bathe.) Amputation at the junction of the middle and distal thirds or at the middle of the penis does not necessarily interfere with the "potentia coeundi" nor with the "potentia generandi."

PLASTIC OPERATION ON THE PENIS

Hypospadias

This consists of an abnormal opening on the inferior wall of the urethra. If situated on the glans penis it [illegible] spoken of as balanic; if on the shaft, penile, etc. [illegible] may be scrotal or perineal in location. Often some deformity exists which should be corrected before repair of the defect is undertaken. Fortunately the abnormal opening in the vast majority of cases of hypospadias is located at the glans penis or immediately below it. These require no surgical intervention. It is different in cases of penile, scrotal or perineal hypospadias, which should be subjected to painstaking surgical repair.

Perineal urethrostomy or suprapubic cystostomy as [illegible] preliminary is not only advisable but often essential to success. Young advocates the procedure warmly. The Young-Stone apparatus enables one to obtain continuous, efficient bladder drainage at the same time keeping the bladder bathed in an antiseptic solution, thus, to frustrate infection.

Perineal Urethrostomy. By this procedure the retention catheter and its evil influences (urethritis, cystitis, etc.) are avoided. The operation consists of cutting an opening in the perineum leading to the bladder. Incisions sufficiently long are made in the skin and urethra which, when united by sutures, form [illegible] mucocutaneous fistula for diverting the urine. The opening is maintained until [illegible] until desired results are obtained. "Until recently," Young says, "almost all hypospadias cases which had been drained through [illegible] perineal urethrostomy have become infected."

VON HACKER-BECK OPERATION

Von Hacker of Germany and Carl Beck of New York popularized this operation which is useful in glandular and anterior penile hypospadias.

The method consists essentially of mobilizing the meatus and anterior portion of the urethra, tunneling the glans penis and advancing the urethra through this tunnel (Figs. [illegible]). A cuff of skin surrounding the meatus urinarius is carefully preserved. The tunnel is made with [illegible] sharp, slender bistoury; the urethra and its supernumerary cuff is brought to the surface of the glans and then sutured in place with Pagenstecher celluloid linen. Young prefers the Duplay operation to this procedure, stating that the curve of the penis already existing is accentuated by this operation.

DUPLAY'S OPERATION FOR GLANDULAR HYPOSPADIAS

This operation is well adapted in cases in which there is [illegible] groove on the under surface of the glans representing the glandular urethra. The edges of the groove are freshened and brought together in the midline over a retention catheter by interrupted sutures of fine silk or chromic catgut. When the flaps are too short to come together without undue tension, lateral incisions into the tissue of the glans penis are made which will overcome this difficulty. The retention catheter [illegible] retained until complete healing takes place.

Comment. Many procedures have been devised and modified for the treatment of hypospadias. There is no procedure which will suit every

[illegible]. Indevelopment[illegible] is necessary before attempting to repair the urethral defect. As already stated, the curvature of the penis must be corrected. The organ is often held down to the scrotum; it must be freed first by transverse incisions which are united in vertical line. The penis must be retained in an extended position while the wounds heal. About six months should elapse before an attempt is made to repair the urethral defect. Do cystostomy

FIG. [illegible] FIG. [illegible] FIG. [illegible] FIG. [illegible]

FIG. [illegible]. Cecil Rock (New York) operation for balanic hypospadias. [illegible] [illegible]

FIG. [illegible]. The skin flap and urethra [illegible] [illegible]

FIG. [illegible]. The [illegible] [illegible]

FIG. [illegible]. The free end of the urethra has been attached [illegible] at the glans penis. The skin flaps have been sutured with interrupted sutures.

Epispadias

The deformity here is on the dorsal surface of the penis. It is rare as compared with hypospadias. It usually is accompanied by deformities of the anterior wall of the bladder, the sphincters of the bladder and urethra as well as the symphysis pubis. Little can be gained in these cases by plastic operation on the urethral defect alone. In these cases the deformity of the penis is corrected first, preceded by urethrostomy.

Operations for Epispadias. As stated, the surgical treatment of epispadias is difficult and tedious, requiring time, patience and skill. The preliminary steps as in the surgical treatment of hypospadias are

1. Urethrostomy
2. Enlargement of the penis.

the latter, after any existing dermatitis has cleared up. (Dilation of constricting bands splitting the penis, etc.)

DUPLAY'S OPERATION ([illegible])

This operation can be carried out only when the urethral sulcus is deep enough to permit the reconstruction of canal of proper caliber. Two parallel areas are

denuded on each side of the urethral sulcus, from the base of the glans penis to the margin of the epispadiac opening and these two areas are united with sutures over catheter placed in the sulcus (Figs. [illegible] [illegible]). After healing of the wounds, the posterior extremity of the new canal thus formed is united by sutures to the margin of the epispadiac opening. To complete the meatus the prepuce may be used.

FIG. [illegible] FIG. [illegible]

FIG. [illegible]. Duplay operation for epispadias. [illegible] [illegible]

FIG. [illegible]. Duplay operation for epispadias. [illegible] Formation of flaps. A, Transverse section [illegible] of flaps X and Y [illegible] C, Transverse section showing flaps X and Y sutured [illegible].

THIERSCH'S OPERATION

In this operation the new urethra is constructed of flaps secured from the penis, prepuce and pubic region.

Step 1. Two rectangular flaps are fashioned on each side of the urethral gutter. One flap is made by longitudinal incision upon the dorsum of one margin of the urethral furrow running parallel with the furrow for its entire extent. Carry an incision at right angles from each extremity of the incision just described out over the side of the penis. Dissect up this flap, which is to become the external surface of the canal formed by the next flap. The base of the flap lies along the outer aspect of the penis (Fig. [illegible]).

Step 2. The second flap fashioned by making two transverse incisions from the anterior and posterior extremities of the other side of the urethral furrow outward over that side of the penis for distance of one centimeter or more, and the extremities of these transverse incisions are connected by an incision which lies upon the other side of the penis running parallel with its axis. The flap is dissected out so that its base runs along the margin of the urethral furrow and it is turned over the furrow so that its skin surface forms the roof of the new urethra and its raw surface is exposed over the new channel.

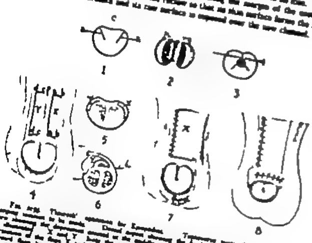

FIG. [illegible]. Thiersch's operation for Epispadias. [illegible] [illegible]

Step 3. Suture the longitudinal margin of this flap along the line of the base of the first flap, the sutures passing through the first flap at its base line.

Step 4. Draw Flap No. over the newly constructed urethra. Suture its longitudinal margin to the corresponding margin at the outer limit of the denuded area on the opposite side of the penis.

Wait until complete healing has taken place.

Step 5. Two orifices remain to be closed now an anterior (the meatus) and posterior (epispadias). The former is closed by plastic procedure consisting of utilizing the prepuce. Make transverse incision through part of the width of the prepuce. Pass the glans through this opening. The prepuce is then united by its incised margin, which has been passed onto the dorsum of the penis, to the freshened edge of the anterior ends of the flaps made at the time of the first operation.

Closure of the posterior opening is accomplished by flaps taken from in front of the pubes, one turned down to be sutured to the posterior end of the canal and second flap turned down to cover the raw surface of the first.

[illegible]'S OPERATION

Step 1. Lift rectangular flap from the under-surface of the penis below the urethral orifice (Fig. [illegible]).

Step 2. Turn the flap up over the catheter which has been placed in the groove of the glans so that the skin surface forms the anterior forming the wall of the new urethra. (Fig. [illegible])

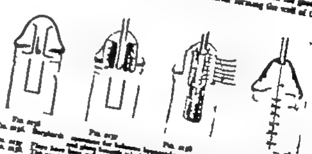

FIG. [illegible] FIG. [illegible] FIG. [illegible] FIG. [illegible]

FIG. [illegible]. [illegible] operation for balanic hypospadias. [illegible] [illegible]

FIG. [illegible]. [illegible] [illegible]

FIG. [illegible]. The penile flap [illegible] [illegible]

FIG. [illegible]. Operation completed.

Step 3. Raise small lateral flap on either side of the glans and insert the lower larger, flap (Fig. [illegible]).

Step 4. Suture the lateral flaps together so that they form the new urethral covering (Fig. [illegible]).

The above operation is especially adaptable to adults.

Operation for Penile and Perineal Hypospadias

There are many different operations to correct this condition. All of them consist in (a) correcting the curvature of the penis and freeing the latter from its attachments to the scrotum and (b) the formation of canal in the penile part of the urethra.

In the formation of new penile urethra, it must be remembered that

Broad surfaces and not skin edges should be brought together no matter what sort of repair one resorts to.

Avoid tension.

3. The circulation of the flaps must not be interfered with.
4. Flaps must be rather over-sized to allow for contraction.
5. Avoidance of infection.
6. In case the operation fails the patient is in no worse condition than before the operation.

Step 2. [illegible] the incision to the aponeurosis of the external oblique muscle; dissect out completely the chain of lymph nodes en masse with the [illegible] subcutaneous tissues, working from above downward and made in such manner that the block of tissue removed will, when completed, [illegible] the portion of the penis to be ablated. Strip the tissues overlying the spermatic cords cleanly. On reaching the femoral regions the dissection extends to the thigh disengaging the lymph nodes of these regions and carrying the dissection into the upper part of the scrotum. "The saphenous and superficial epigastric veins," says Young, "should be sacrificed, the cribriform fascia excised, and the deep group of femoral nodes dissected away cleanly from the artery and vein. This is necessary because some channels from the glans run directly to the deep group of the lymph nodes."

Step 3. It is usually necessary to divide the penis at its base and excise the bulb and corpora cavernosa. Divide the suspensory ligament of the penis. Dissect from above downward to a point where the corpora cavernosa are to be divided. Divide these transversely after first applying [illegible] rubber constrictor to the upper segment of the remaining stump.

Step 4. Treat the corpora cavernosa, the corpus spongiosum and the urethra as outlined above in partial removal of the penis. (Steps 4, 5, 6 and 7 above.)

Total Extirpation of the Penis—Divided[1] Technic

Alexander J. Dzialo of [illegible] described the following surgical technic.

Step 1. Skin Incision. The patient [illegible] placed on the back with legs elevated by [illegible] Dubois. The limbs are prepared and fixed upon the abdomen. Make an incision through the skin of the [illegible] raphé about [illegible] cm. in length ending about [illegible] cm. in front of the anus (Fig. [illegible]).

Step 2. Isolation of the Corpora Cavernosa and the Urethra. After the urethra has been exposed, isolate the corpora cavernosa from the contiguous structures by a [illegible] dissector and hold the parts with [illegible] Farabeuf retractor (Fig. [illegible]).

Step 3. Dissection and Division of the Urethra. The urethra is dissected free and detached from the corpora cavernosa for about [illegible] cm. Divide it transversely (Fig. [illegible]). During the dissection of the urethra one must proceed through [illegible] proper line of cleavage and so keep away as much as possible from the corpora cavernosa. Loss of blood is thus avoided.

Step 4. Division of the Corpora Cavernosa. After the urethra has been divided, displace [illegible] laterally or downward. Divide transversely the corpora cavernosa as near as possible to their ischiopubic insertions. Clamp the dorsal vessels of the penis with artery forceps and [illegible] an [illegible] compressing the proximal end of the corpora cavernosa, place [illegible] clamp on their distal ends. This reduces bleeding considerably (Fig. [illegible]).

Step 5. Suture of the Corpora Cavernosa. The ends of the corpora cavernosa are sutured with interrupted catgut sutures. Ligate the dorsal vessels of the penis (Fig. [illegible]).

Step 6. Completion of Extirpation of the Penis. Make an incision into the skin encircling the root of the penis. Prolong this incision on both sides laterally over the scrotum, the lateral incisions joining the ends of those

[1] [illegible]

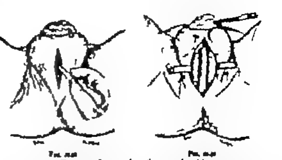

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Incision along the perineal raphé.

Fig. [illegible] Isolation of the corpora cavernosa and of the urethra.

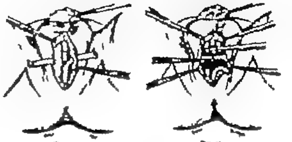

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Dissection and division of the urethra.

Fig. [illegible] Division of the corpora cavernosa.

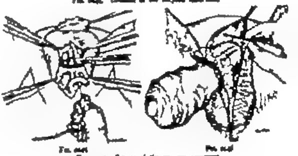

Fig. [illegible] Fig. [illegible]

Fig. [illegible] Suture of the corpora cavernosa.

Fig. [illegible] [illegible] of the corpora cavernosa and of [illegible] portion of the urethra, [illegible] (Courtesy, Dr. A. J. Dzialo.)

made on the median raphé. Endeavor to remove as much as possible of the scrotum. Divide above and below the suspensory ligament of the penis and the attachments of the corpora cavernosa. When the anterior surface is reached, the penis together with [illegible] portion of the scrotum are removed en bloc (Fig. [illegible]).

Step 7. Suture of the Scrotum. Begin at the pubic end and close the lips of the wound of the scrotum by interrupted silk sutures. Continue in the fashion indicated in Fig. [illegible].

Step 8. Implantation of the Urethra into the Perineum. Split the urethra for about [illegible] cm. on its lower surface, and suture it to the skin of the perineum.

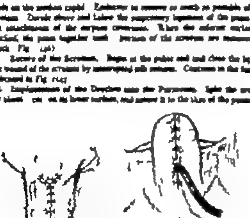

Fig. [illegible] Fig. [illegible]

Fig. [illegible] [illegible] anterior view of the [illegible] region.

Fig. [illegible] View of the [illegible] region. The [illegible] end of the urethra [illegible] sutured to the perineum. (Courtesy of Dr. [illegible] J. Dzialo.)

Pass a retention catheter into the urethra and permit [illegible] to remain there during the time of healing—approximately [illegible] days (Fig. [illegible]).

Comment. After the operation is completed and the structures united properly, it will give the appearance of [illegible] penis. It is for this reason that sufficient tissue from the scrotum should be removed. It will be noted that after cicatrization has taken place and the catheter removed, the patient will urinate standing without wetting the scrotum. This together with the appearance of the newly shaped scrotum will tend to alleviate the mental suffering of these patients.

Most surgeons object to complete emasculation, [illegible] procedure Robert [illegible] of Rome strongly advocates. Young comments on this operation as follows: "In our experience, patients object seriously to such mutilation. [illegible] some of them are able to have fairly satisfactory coitus after even very extensive resections of the penis."

The thought is comforting that carcinoma of the penis is usually of slow growth. (Bookm.) Amputation at the junction of the middle and distal thirds or in the middle of the penis does not necessarily interfere with the "potentia coeundi" nor with the "potentia generandi."

PLASTIC OPERATION ON THE PENIS

Hypospadias

This consists of an abnormal opening on the inferior wall of the urethra. If situated on the glans penis [illegible] is spoken of as balanic; if on the shaft, penile; or, it may be scrotal or perineal in location. Often some deformity exists which should be corrected before repair of the defect is undertaken. Fortunately the abnormal opening in the vast majority of cases of hypospadias is located at the glans penis or immediately below it. These require no surgical intervention. It [illegible] different in cases of penile, scrotal or perineal hypospadias, which should be subjected to painstaking surgical repair.

Perineal urethrotomy or suprapubic cystostomy as [illegible] preliminary is not only advisable but often essential to success. Young advocates the procedure warmly. The Young [illegible] apparatus enables one to obtain continuous, efficient bladder drainage at the same time keeping the bladder locked in an antiseptic solution, thus, to frustrate infection.

Perineal Urethrostomy. By this procedure the retention catheter and its evil influences (urethritis, cystitis, etc.) are avoided. The operation consists of cutting an opening in the perineum leading to the bladder. Incisions sufficiently long are made in the skin and urethra which, when united by sutures, form [illegible] mucocutaneous fistula for diverting the urine. The opening is maintained [illegible] until desired results are obtained. "Until recently," Young says, "almost all hypospadias cases which had been drained through [illegible] perineal urethrostomy [illegible] have become infected."

[illegible] OPERATION

Von [illegible] of Germany and Carl Beck of New York popularized this operation which is useful in glandular and anterior penile hypospadias.

The method consists essentially of mobilizing the meatus and anterior portion of the urethra, tunneling the glans penis and advancing the urethra through this tunnel (Figs. [illegible]). A rim of skin surrounding the meatus [illegible] carefully preserved. The tunnel is made with [illegible] sharp, slender bistoury; the meatus and its appendages [illegible] is brought to the surface of the glans and then sutured in place with [illegible] catheter [illegible]. Young prefers the Duplay operation to this procedure, stating that the curve of the penis already existing is accentuated by this operation.

[illegible] OPERATION FOR GLANDULAR HYPOSPADIAS

This operation is well adapted to cases in which there is [illegible] groove on the under surface of the glans representing the glandular urethra. The edges of this groove are freshened and brought together in the midline over [illegible] retention catheter by interrupted sutures of fine silk or chromic catgut. When the flaps are too short to come together without undue tension, lateral incisions into the tissues of the glans penis are made which will overcome this difficulty. The retention catheter is retained until complete healing takes place.

Comment. Many procedures have been devised and modified for the treatment of hypospadias. There is no procedure which will suit every

condition. Indwelling catheter is necessary before attempting to repair the urethral defect. As already noted, the curvature of the penis must be corrected. The organ is often held down to the scrotum; it must be freed first by transverse incisions which are sutured in a vertical line. The penis must be retained in an extended position while the wounds heal. About six months should elapse before an attempt is made to repair the urethral defect. Do [illegible] cystostomy.

FIG. [illegible] FIG. [illegible] FIG. [illegible] FIG. [illegible]

FIG. [illegible]. Carl Beck [illegible] operation for balanitic hypospadias, [illegible] of mucosa closed below the urinary glands, [illegible] the abnormal opening and longitudinal lines extending from the middle of the latter.

FIG. [illegible]. The skin flap and urethra have been dissected free. A knife [illegible] thrust through the head of the penis to form [illegible] tunnel through which the urethra [illegible] to be passed.

FIG. [illegible]. The mobilized urethra has been passed through the tunnel [illegible] by the knife and brought out with [illegible] of tissue [illegible] the surface of the glans penis.

FIG. [illegible]. The free end of the urethra has been attached with interrupted sutures to the aperture created in the glans penis. The skin flaps have been closed with interrupted sutures.

Epispadias

The deformity here is on the dorsal surface of the penis. It is rare as compared with hypospadias. It usually is accompanied by deformities of the anterior wall of the bladder, the sphincters of the bladder and urethra as well as the symphysis pubis. Little can be gained in these cases by a plastic operation on the urethral defect alone. In these cases the deformity of the penis is corrected first, preceded by [illegible] cystostomy.

Operations for Epispadias. As stated, the surgical treatment of epispadias is difficult and tedious, requiring time, patience and skill. The preliminary steps as in the surgical treatment of hypospadias are:

1. Cystostomy.
2. Straightening of the penis.

the latter, after any existing dermatitis has cleared up. (Division of constricting bands [illegible] splinting the penis, etc.)

DUPLAY'S OPERATION ([illegible])

This operation can be carried out only when the urethral sulcus is deep enough to permit the reconstruction of [illegible] canal of proper caliber. Two parallel areas are

denuded on each side of the urethral sulcus, from the base of the glans penis to the margin of the epispadiac opening and these two areas are united with sutures over [illegible] catheter placed in the sulcus (Figs. [illegible]). After healing of the wounds, the posterior extremity of the new canal thus formed is united by sutures to the margin of the epispadiac opening. T[illegible] complete the suture the prepuce may be used.

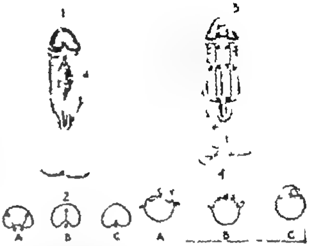

FIG. [illegible] FIG. [illegible]

FIG. [illegible]. Duplay [illegible] operation for hypospadias. [illegible] Reduction of the [illegible] for the purpose of straightening the penis. A. Make [illegible] incision [illegible] B. [illegible] C. Perform the [illegible] [illegible] the [illegible] Lupton.

FIG. [illegible]. Duplay's operation for hypospadias. [illegible] Formation of flaps. A. Transverse section showing [illegible] of flaps X and Y [illegible] B. Transverse section illustrating the flaps X and Y [illegible] C. Transverse section showing flaps X and Y [illegible].

THIERSCH'S OPERATION

In this operation the new urethra is constructed of flaps secured from the penis, prepuce and pubic region.

Step [illegible]. Two rectangular flaps are fashioned on each side of the urethral gutter. One flap is made by [illegible] longitudinal incision upon the [illegible] of one margin of the urethral furrow, running parallel with the furrow for its entire extent. Carry an incision at right angles from each extremity of the incision just described out over the side of the penis. Dissect up this flap, which is to become the internal surface of the canal formed by the next flap. The base of the flap lies along the outer aspect of the penis (Fig. [illegible]).

Step 2. The second flap is fashioned by making two transverse incisions from the anterior and posterior extremities of the other side of the urethral furrow outward over the side of the penis for [illegible] distance of one centimeter or more and the extremities of these transverse incisions are connected by an incision which lies upon the other side of the penis running parallel with its axis. The flap is dissected out so that its base runs along the margin of the urethral furrow and [illegible] is turned over the furrow so that its skin surface forms the roof of the new urethra and its raw surface [illegible] exposed over the new channel.

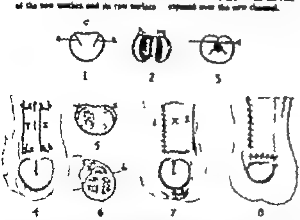

FIG. [illegible]. Thiersch [illegible] operation for Epispadias. [illegible] Transverse view [illegible] incision to be made. [illegible] Dorsal aspect showing the [illegible] edges. [illegible] Transverse view showing the [illegible] in the middle [illegible] with [illegible]. [illegible] of flaps [illegible] X and Y [illegible] the [illegible] of the epispadiac opening. [illegible] the [illegible] of the flaps X and Y [illegible]. [illegible] Transverse section [illegible] the [illegible] flaps [illegible]. [illegible] The dorsal flap X [illegible] in place. [illegible] the third stage [illegible] completed. [illegible] The prepuce [illegible] split and brought over the glans penis to cover the [illegible].

Step 3. Suture the longitudinal margin of this flap along the line of the base of the first flap, the sutures passing through the first flap at its base line.

Step 4. Draw Flap No. [illegible] over the newly constructed urethra. Suture its longitudinal margin to the corresponding margin at the outer limit of the denuded area on the opposite side of the penis.

Wait until complete healing has taken place.

Step 5. Two orifices remain to be closed now: an anterior (the meatus) and posterior (epispadiac). The former is closed by [illegible] plastic procedure consisting of splitting the prepuce. Make [illegible] transverse incision through [illegible] part of the width of the prepuce. Pass the glans through this opening. The prepuce is now united by its freshed margin, which has been passed onto the dorsum of the penis, to the freshened edge of the anterior ends of the flaps made at the time of the first operation.

Closure of the posterior opening is accomplished by flaps taken from in front of the pubes, one turned down to be sutured to the posterior end of the united and second flap turned down to cover the raw surface of the first.

[illegible] OPERATION

Step 1. Lift [illegible] rectangular flap from the under-surface of the penis below the urethral orifice (Fig. [illegible]).

Step 2. Turn the flap up over the catheter which has been placed in the groove of the glans so that the skin surface faces the interior forming the wall of the new urethra (Fig. [illegible]).

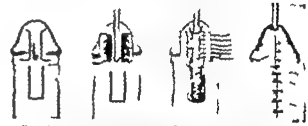

FIG. [illegible] FIG. [illegible] FIG. [illegible] FIG. [illegible]

FIG. [illegible]. [illegible] operation for balanitic hypospadias. [illegible] outline of incisions [illegible] and glans [illegible] which the flap [illegible] to be placed.

FIG. [illegible]. Flaps have been reflected and catheter introduced through the epispadiac opening.

FIG. [illegible]. The penile flap is turned up [illegible] and the remaining [illegible] have been [illegible] on one side.

FIG. [illegible]. Operation completed.

Step 3. Raise [illegible] small lateral flap on either side of the glans and insert the lower, larger, flap (Fig. [illegible]).

Step 4. Suture the lateral flaps together so that they form the new urethral covering (Fig. [illegible]).

The above operation is especially adaptable to adults.

Operations for Penile and Perineal Hypospadias

There are many different operations to correct this condition. All of them consist in (a) correcting the curvature of the penis and freeing the latter from its attachments to the scrotum and (b) the formation of [illegible] canal in the penile part of the urethra.

In the formation of [illegible] new penile urethra, [illegible] must be remembered that

[illegible] Broad surfaces and not thin edges should be brought together no matter what sort of repair one resorts to.

[illegible] Avoid tension.

3. The chordaiten of the flaps must not be considered such.

4. Flaps must be rather over-sized to allow for contraction.

5. Avoidance of infection.

6. In case the operation fails the patient is in no worse condition than before the operation.

Step 2. Deepen the incision to the aponeurosis of the external oblique muscle, dissect out completely the chain of lymph nodes en masse with the superimposed subcutaneous tissue, working from above downward and inside so such manner that the block of tissue removed will, when completed, embrace the portion of the penis to be ablated. Strip the tissues overlying the spermatic cords cleanly. On reaching the femoral regions the dissection extends to the thigh disengaging the lymph nodes of these regions and carrying the dissection into the upper part of the scrotum. "The saphenous and superficial epigastric veins," says Young, "should be sacrificed, the cribriform fascia incised, and the deep group of femoral nodes dissected away cleanly from the artery and vein. This is necessary because some channels from the glans run directly to the deep group of the lymph nodes."

Step 3. It is usually necessary to divide the penis at its base and excise the bulb and corpora cavernosa. Divide the suspensory ligament of the penis. Dissect from above downward to the point where the corpora cavernosa are to be divided. Divide these transversely after first applying a rubber constrictor to the upper segment of the remaining stump.

Step 4. Treat the corpora cavernosa, the corpus spongiosum and the urethra as outlined above in partial removal of the penis. (Steps 4, 5, 6 and 7 above.)

Total Extirpation of the Penis—Dömínez' Technic

Alexander J. Dávalos of Paraguay described the following surgical technic.

Step 1. Skin Incision. The patient is placed on the back with legs elevated by cushions. The limbs are prepared and fixed upon the abdomen. Make an incision through the skin of the penoscrotal raphé about 8 cm. in length ending about 3 cm. in front of the anus (Fig. [illegible]).

Step 2. Isolation of the Corpora Cavernosa and the Urethra. After the urethra has been exposed, isolate the corpora cavernosa from the contiguous structures by a grooved director and hold the parts with a Farabeuf retractor (Fig. [illegible]).

Step 3. Dissection and Division of the Urethra. The urethra is dissected free and detached from the corpora cavernosa for about 3 or [illegible] cm. divide it transversely (Fig. [illegible]). During the dissection of the urethra one must proceed through a proper line of cleavage and to keep away as much as possible from the corpora cavernosa. Loss of blood is thus avoided.

Step 4. Division of the Corpora Cavernosa. After the urethra has been divided, displace it laterally or downward. Divide transversely the corpora cavernosa as near as possible to their ischiopubic insertions. Clamp the dorsal vessels of the penis with artery forceps and while an assistant compresses the proximal end of the corpora cavernosa, place a clamp on their distal ends. This reduces bleeding considerably (Fig. [illegible]).

Step 5. Suture of the Corpora Cavernosa. The ends of the corpora cavernosa are sutured with interrupted catgut sutures. Ligate the dorsal vessels of the penis (Fig. [illegible]).

Step 6. Completion of Extirpation of the Penis. Make an incision into the skin encircling the root of the penis. Prolong this incision on both sides laterally over the scrotum, the lateral incisions joining the ends of those

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Fig. [illegible]. Incision along the scrotal raphé.
Fig. [illegible]. Isolation of the corpora cavernosa and of the urethra.

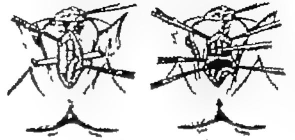


Fig. [illegible]. Dissection and division of the urethra.
Fig. [illegible]. Division of the corpora cavernosa.

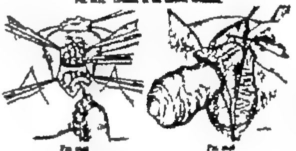


Fig. [illegible]. Suture of the corpora cavernosa.
Fig. [illegible]. Freeing of the corpora cavernosa and of a portion of the scrotum from above downward. (Courtesy, Dr. A. J. Dávalos.)

made on the median raphé. Endeavor to remove as much as possible of the scrotum. Divide above and below the suspensory ligament of the penis and the attachments of the corpora cavernosa. When the bilateral surface is reached, the penis together with a portion of the scrotum are removed en block (Fig. [illegible]).

Step 7. Suture of the Scrotum. Begin at the pubic end and close the lips of the wound of the scrotum by interrupted silk sutures. Continue in the fashion indicated in Fig. [illegible].

Step 8. Implantation of the Urethra Into the Perineum. Split the urethra for about [illegible] cm. on its lower surface, and suture it to the skin of the perineum.

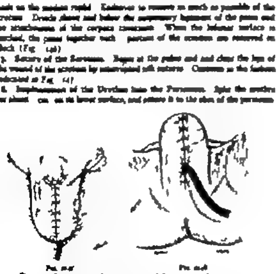


Fig. [illegible]. Fig. [illegible].
Fig. [illegible]. Incision sutured, anterior view of the penoscrotal segment.
Fig. [illegible]. View of the penoscrotal aspect. The central end of the urethra [illegible] sutured to the perineum.
(Courtesy of Dr. A. J. Dávalos.)

Pass a retention catheter into the urethra and permit it to remain there during the time of healing—approximately 8 to 10 days (Fig. [illegible]).

Comment. After the operation is completed and the structure sutured properly, it will give the appearance of a penis. It is for that reason that sufficient tissue from the scrotum should be removed. It will be noted that after convalescence has taken place and the catheter removed, the patient will urinate standing without wetting the scrotum. This together with the appearance of the newly shaped scrotum will tend to alleviate the mental suffering of these patients.

Most surgeons object to complete emasculation, a procedure Robert Alexander of Rome strongly advocates. Young comments on this question as follows: "In our experience, patients object seriously to such mutilation since some of them are able to have fairly satisfactory coitus after even very extensive resections of the penis."

The thought in conducting that carcinoma of the penis is usually of slow growth. (Butler.) Amputation at the junction of the middle and distal thirds or at the middle of the penis does not necessarily interfere with the "potentia coeundi" nor with the "potentia generandi."

PLASTIC OPERATION ON THE PENIS

Hypospadias

This consists of an abnormal opening on the inferior wall of the urethra. If situated on the glans penis it is spoken of as balanitic (if on the shaft, penile) or, it may be scrotal or perineal in location. Often some deformity exists which should be remedied before repair of the defect is undertaken. Fortunately the abnormal opening in the vast majority of cases of hypospadias is located at the glans penis or immediately below it. These require no surgical intervention. It is different in cases of penile, scrotal or perineal hypospadias, which should be subjected to painstaking surgical repair.

Perineal urethrostomy or suprapubic cystostomy is a preliminary [illegible] not only advisable but often essential to success. Young advocates the procedure strongly. The Young-Shaw apparatus enables one to obtain continuous, efficient bladder drainage at the same time keeping the bladder bathed in an antiseptic solution, thus, to frustrate infection.

Perineal Urethrostomy. By this procedure the retention catheter and its evil influences (urethritis, cystitis, etc.) are avoided. The operation consists of cutting an opening in the perineum leading to the bladder. Incisions sufficiently long are made in the skin and urethra which, when united by sutures, form a mucocutaneous fistula for diverting the urine. The opening [illegible] remains in service until desired results are obtained. "Until recently," Young says, "almost all hypospadias cases which had been drained through a perineal retention catheter have become infected."

VON HACKER-BECK OPERATION

Von Hacker of Germany and Carl Beck of New York popularized this operation which is useful in glandular and anterior penile hypospadias.

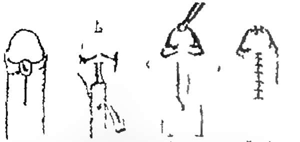
The method consists essentially of mobilizing the meatus and anterior portion of the urethra, tunneling the glans penis and advancing the urethra through this tunnel (Figs. [illegible]). A cuff of skin surrounding the meatus urinarius is carefully preserved. The tunnel is made with a sharp, slender, bistoury; the meatus and its supplementary cuff is brought to the surface of the glans and then sutured in place with Pagenstecher celluloid linen. Young prefers the Duplay operation to this procedure, stating that the curve of the penis already existing is accentuated by this operation.

DUPLAY OPERATION FOR GLANDULAR HYPOSPADIAS

This operation is well adapted to cases in which there is a groove on the under surface of the glans representing the glandular urethra. The edges of this groove are freshened and brought together in the midline over a retention catheter by interrupted sutures of fine silk or chromic catgut. When the flaps are too short to come together without undue tension, lateral incisions into the tissues of the glans penis are made which will overcome this difficulty. The retention catheter is retained until complete healing takes place.

Comment. Many procedures have been devised and modified for the treatment of hypospadias. There is no procedure which will suit every

[illegible] is necessary before attempting to repair the urethral defect. As already stated, the curvature of the penis must be corrected. The organ is often held down to the scrotum; it must be freed first by transverse incisions which are sutured in vertical lines. The penis must be corrected by an extended position while the wounds heal. About six months should elapse before an attempt is made to repair the urethral defect. Do cystotomy.



[illegible]

Epispadias

The deformity here is on the dorsal surface of the penis. It is rare as compared with hypospadias. It usually is accompanied by deformity of the anterior wall of the bladder, the sphincter of the bladder and urethra as well as the symphysis pubis. Little can be gained in these cases by a plastic operation on the urethral defect alone. In these cases the deformity of the penis is corrected first, preceded by cystotomy.

Operations for Epispadias. As stated, the surgical treatment of epispadias is difficult and tedious, requiring time, patience and skill. The preliminary steps as in the surgical treatment of hypospadias are:

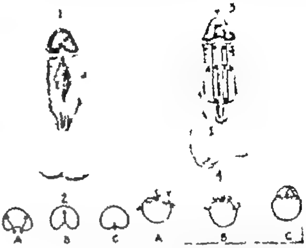
Cystotomy
Straightening of the penis.

the latter, after any existing dermatitis has cleared up. (Dilatation of contracting bands, splitting the penis, etc.)

[illegible]

This operation can be carried out only when the urethral sulcus is deep enough to permit the reconstruction of a canal of proper caliber. Two parallel incisions are

deepened on each side of the urethral sulcus, from the face of the glans penis to the margin of the epispadiac opening and these two areas are united with sutures over a catheter placed in the sulcus (Figs. [illegible]). After healing of the wounds, the posterior extremity of the new canal thus formed is united by sutures to the margin of the epispadiac opening. To complete the sutures the prepuce may be used.



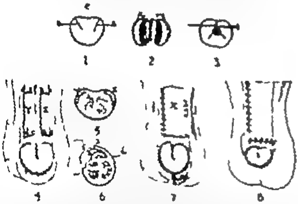
[illegible]

[illegible] OPERATION

In this operation the new urethra is constructed of flaps secured from the penis, prepuce and pubic region.

Step 1. Two rectangular flaps are fashioned on each side of the urethral gutter. One flap is made by a longitudinal incision upon the summit of one margin of the urethral furrow, running parallel with the furrow for its entire extent. Carry an incision at right angles from each extremity of the incision just described out over the side of the penis. Dissect up this flap, which is to become the external surface of the canal formed by the next flap. The base of the flap lies along the outer aspect of the penis (Fig. [illegible]).

Step 2. The second flap is fashioned by making two transverse incisions from the anterior and posterior extremities of the other side of the urethral furrow, outward over that side of the penis for a distance of [illegible], and the extremities of these transverse incisions are connected by an incision which lies upon the other side of the penis running parallel with its axis. This flap is dissected out so that its base rests along the margin of the urethral furrow and it is turned over the furrow so that its skin surface forms the roof of the new urethra and its raw surface is exposed over the new channel.



[illegible]

Step 3. Suture the longitudinal margin of this flap along the base of the base of the first flap, the sutures passing through the first flap at its base line.

Step 4. Draw Flap [illegible] over the newly constructed urethra. Suture the longitudinal margin to the corresponding margin at the outer limit of the denuded area on the opposite side of the penis.

Wait until complete healing has taken place.

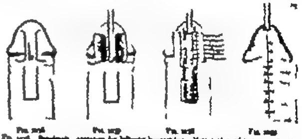
Step 5. Two orifices remain to be closed now, an anterior (the meatus) and posterior (epispadiac). The former is closed by plastic procedure consisting of utilizing the prepuce. Make transverse incision through part of the width of the prepuce. Pass the glans through this opening. The prepuce is now united by its incised margin, which has been passed over the dorsum of the penis, to the freshened edge of the anterior ends of the flaps made at the time of the first operation.

Closure of the posterior opening is accomplished by flaps taken from in front of the pubes, one turned down to be sutured to the posterior end of the canal and second flap turned down to cover the raw surface of the first.

[illegible] OPERATION

Step 1. Lift rectangular flap from the under-surface of the penis below the urethral sulcus (Fig. [illegible]).

Step 2. Turn the flap up over the catheter which has been placed in the groove of the glans so that the skin surface faces the catheter forming the wall of the new urethra. (Fig. [illegible])



[illegible]

Step 3. Raise a small lateral flap on either side of the glans and unite the lower, larger flap (Fig. [illegible]).

Step 4. Suture the lateral flaps together so that they form the new urethral covering (Fig. [illegible]).

The above operation is especially adaptable to adults.

Operation for Penile and Perineal Hypospadias

There are many different operations to correct this condition. All of them consist in (a) correcting the curvature of the penis and freeing the latter from its attachments to the scrotum and (b) the formation of a canal in the penile part of the urethra.

In the formation of a new penile urethra, it must be remembered that

1. Raw surfaces and not skin edges should be brought together no matter what sort of repair one resorts to.
2. Avoid tension.
3. The circulation of the flaps must not be interfered with.
4. Flaps must be rather over-sized to allow for contraction.
5. Avoidance of infection.
6. In case the operation fails the patient is in no worse condition than before the operation.

7. Use [illegible] plan for the formation of [illegible] new urethra.
8. Divert the urinary stream.

No matter what type of operation is used, the first thing to do is correct the curvature of the penis. This is accomplished as follows:

Make [illegible] transverse incision dividing the fibrous band which attaches the penis to the scrotum. The penis must be completely liberated, and straightened. To accomplish this purpose the incision may have to be extended into the sheath of the corpora cavernosa. This accomplished, the incision is closed by longitudinal sutures. Apply dressings and place the penis in [illegible] position of overcorrection onto the abdomen supported by [illegible] splint until healing is complete.

[illegible] METHOD OF [illegible] THE PENIS

Step 1. Insert [illegible] trocar transversely through the corpora cavernosa just over the line of fibrous union causing the curvature. Remove the trocar.

Step 2. Place [illegible] skin graft which has been taken from the inner surface of the thigh, and which includes all layers of skin, with the skin side up, around the trocar using two or three fine catgut sutures to hold it securely.

Step 3. Reintroduce the trocar carrying the skin graft through the puncture. Slip the skin graft off and hold in place with two sutures at each end.

Step 4. Place two or three grafts (three if necessary) about [illegible] cm. apart. Dress.

Drain the urine by placing [illegible] retention catheter in the urethra. After two or three weeks, divide the graft on [illegible] grooved director from within outward. After four or six weeks [illegible] smooth surface, free from scar formation, should result.

The reconstruction of the urethra should be undertaken from three to six months after the first step of the operation is completed.

[illegible] OPERATION FOR THE CORRECTION OF [illegible] HYPOSPADIAS

[illegible] stresses the difficulties encountered in attempting by plastic operations [illegible] new urethra in cases of penoscrotal and scrotal forms of hypospadias. [illegible] points out that transplantation of segments of veins, ureter or appendix is only seldom followed by success. Also, that the various methods of flap plastic according to Thiersch, Beck, Duplay and others have not been followed by the desired results. This, perhaps, because the skin of the scrotum [illegible] on one side [illegible] to [illegible]. However, in order to take advantage of using the skin of the scrotum for these plastic procedures and to insure the nutrition of the flaps, [illegible] devised [illegible] method of operating which is performed in three stages. This procedure has improved the outlook for recovery in this class of distressing conditions.

Stage I

Step 1. Do [illegible] (perineal) urethrotomy and introduce an indwelling catheter.

Step 2. Make two parallel incisions on the under surface of the penis the length of which is indicated by the demands for covering the urethral defect (Fig. [illegible]). In order to obtain broad surfaces for healing, the incisions are extended by sharp and blunt dissection. Place the penis on the scrotal skin in such [illegible] manner that the [illegible] external urethral orifice corresponds to the lower ends of the incisions. The opposed margins of the incision are united with interrupted fine sutures of silk.

[illegible] [illegible]

Stage II

This is done eight days after the first stage of the operation.

Step 1. Remove ½ cm. of both longitudinal scars.

Step 2. Make two parallel [illegible] incisions on the scrotum as shown in Fig. [illegible].

Step 3. Elevate the skin between these two incisions creating [illegible] bridge flap by blunt dissection as shown in Fig. [illegible].

Step 4. Close the edges of the bridge of skin thus created and close the wound surfaces on the scrotum with interrupted silk sutures. Fig. [illegible]

Fig. [illegible] Fig. [illegible]

Fig. [illegible] [illegible] [illegible] of scrotal hypospadias. Parallel incisions on undersurface of the penis, [illegible] [illegible] defect.

Fig. [illegible] Parallel incisions on scrotum.

Stage III

In order to counteract the tendency of the penis to contract, [illegible] rubber tube is inserted between penis and scrotum, three or four days after the second stage of the operation and the penis is extended as shown in Fig. [illegible]. Eight days after the above procedure the bridge flap attached to the glans penis is divided. This concludes the plastic of the urethra. An appropriate sound may then be introduced (bougienage) into the urethra. [illegible] recommends that an indwelling catheter be permitted to remain in the newly formed urethra for [illegible] number of days.

Comments. It may be argued against this operation, [illegible] states, that it takes three sessions to accomplish the desired result. If one takes into consideration the drawbacks of one-stage operations which result, as [illegible] in more or less extensive necrosis with fistulization, demanding [illegible] number of secondary operations the advantages of this procedure become apparent.

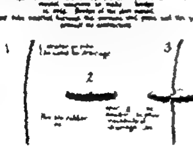
Arthur B. Cecil[illegible] made an exhaustive study of the literature on the surgical treatment of these conditions from the efforts of Duplay [illegible] ([illegible]) up to the present time. He stresses that "the whole operation is [illegible] [illegible] of surgical [illegible] which [illegible] [illegible]" and points out that many splendid operations have been ruined by the neglect

[illegible] [illegible] [illegible]

Fig. [illegible] Fig. [illegible] Fig. [illegible]

Fig. [illegible] [illegible] operation for scrotal hypospadias. Division of the skin bridge [illegible] [illegible] [illegible].

Fig. [illegible] Rubber tube inserted between the scrotum and penis and the penis extended, [illegible] [illegible] contraction.



of some small detail and that experience taught him that 25 per cent [illegible] [illegible] immediately [illegible] [illegible] with alcohol is the most satisfactory method of preparation. [illegible] [illegible] [illegible] per cent [illegible] [illegible] in the hypospadic urethra. While [illegible] [illegible] [illegible] [illegible] to be [illegible] [illegible], Cecil [illegible] [illegible] plain catgut for buried sutures and black silk for skin approximation best. Sutures should be

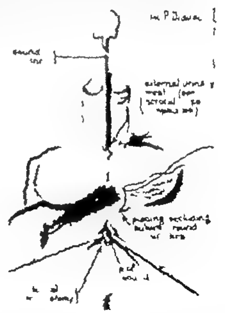


Fig. [illegible] [illegible] drainage and [illegible] of the urethra after [illegible]. Courtesy of Dr. Arthur B. Cecil.

interrupted. Failure to obtain [illegible] [illegible] to the greatest number of failures. Diverting the urine during the process of healing is essential. Such drainage should be done about ten days prior to doing the plastic work (Fig. [illegible]). In penile and penoscrotal hypospadias perineal drainage is resorted to (Fig. [illegible]). Sutures should be tight enough to include the urethra but not so tight as to cut into it. The credit for having first introduced perineal drainage belongs to Thiersch. Operations for deformity of the penis should be done early in life. In subsequent operations several years later suprapubic drainage should sometimes supplement perineal

drainage. No operation should be done for minor degrees of hypospadias in childhood. Subcutaneous division of the fibrous bands was first carried out by Duplay and is most universally used today. Buck [illegible] and all constricting bands must be thoroughly divided. The deformity must be corrected thoroughly. Cecil advises against making an opening in the glans penis but insists that the urethral canal terminates at the frenum. He uses the foreskin for the reconstruction of [illegible] portion of the penile urethra in perineal hypospadias and points out that the flaps must have broad base, be constructed from the penis itself and give the assurance that

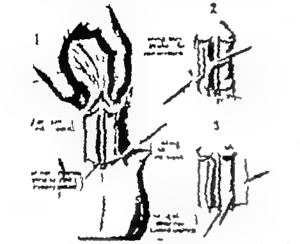


Fig. [illegible] Adaptation of Thiersch method for reconstructing the urethra in penile hypospadias. [illegible]
(Courtesy of Dr. A. B. Cecil.)

the canal will develop with the development of the penis. Thiersch's operation has [illegible] distinct advantages over Duplay. In that the broad surfaces [illegible] one another and thus there is [illegible] as that one flap in contracting tends to pull the other flap in position and vice versa. Thiersch operation is [illegible] more difficult one to perform but the results are better. The steps of this operation for penile and penoscrotal hypospadias are depicted in Figs. [illegible]. Figures [illegible] show the results obtained by Cecil in using the Thiersch's operation in [illegible] boy of 17 with penoscrotal hypospadias. Thiersch operation is of equal value in perineal hypospadias. Here the perineal outlet is utilized for the passage of urine. After the urethra is satisfactorily reconstructed, do [illegible] suprapubic drainage and close the perineal opening by Duplay's method. Figures [illegible] depict [illegible] case of perineal

hypospadias cured by the Thiersch method. Where Thiersch method fails Bucknall's operation or one of its modifications such as the operation of Landerer and Bidder may be used as a secondary procedure. Where all methods fail, Pickerall['s] operation should be given [illegible] trial. This consists of forming [illegible] tubular graft from the skin of the abdomen. The urethra is

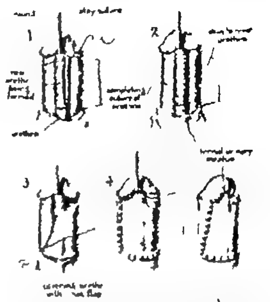


Fig. [illegible] Hypospadias. [illegible]
(Courtesy of Dr. Arthur B. Cecil.)

gradually constructed in stages. In epispadias, Thiersch's operation is excellent. [illegible] referred to it as one of the most brilliant achievements in practical surgery. In these cases the reestablishment of continence is [illegible] problem. Young (1922) devised an operation for bringing together the vesical sphincter by suprapubic approach in addition to the successful cases reported by Young. [illegible] and others reported successes. The following conclusions are arrived at by Cecil

In attempting to reconstruct deformities of the urethra the urologic

[illegible]

surgeon should familiarize himself thoroughly with the principles of plastic surgery.

[illegible] result can be obtained unless an absolute diversion of the urinary stream and this is not likely to be brought about except by [illegible] of the urethra by suture.

Fig. [illegible] Fig. [illegible]
Fig. [illegible] Result of Thiersch operation for penoscrotal hypospadias. [illegible]

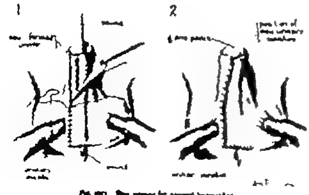


Fig. [illegible] [illegible] for perineal hypospadias.
(Courtesy of Dr. [illegible] B. Cecil.)

3. No drainage tubes, probes, nor any other foreign bodies should be left in the newly formed urethra.

4. The primary operation for the correction of the deformity of the

penis should be done during the first two years of life. It should be complete and no other operations should be done until the deformity is proven to have been cured.

5. Heteroplastic grafts are of no value for the reconstruction of the urethra.

6. There is much experimental evidence and clinical evidence against the use of isoplastic grafts and it is very doubtful as to whether one should attempt to reconstruct [illegible] urethra from them.

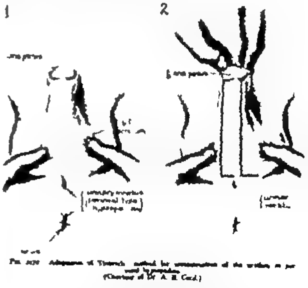


Fig. [illegible] Adaptation of Thiersch method for construction of the urethra in perineal hypospadias.
(Courtesy of Dr. A. B. Cecil.)

7. Autoplastic free grafts such as the use of the appendix or the use of veins, arteries, or free skin grafts after the method of Nove-Josserand, are very unsatisfactory in reconstructing the urethra, and although occasional results have been made by the use of this material the results have almost universally been bad.

8. The advancement of the urethral operation of Beck of New York is of use only in very minor degrees of hypospadias. In cases that probably should not be operated at all, in more extreme degrees of hypospadias, it is likely to result in failure or in the production of [illegible] condition worse than previous to the operation.

9. Cecil's operation of using [illegible] pedicle graft of the [illegible] skin has

not been sufficiently tried to warrant its use. Among other objections to it is that the vein is likely to be too small or is likely to be branched.

FIG. [illegible]. Method of [illegible] (Cecil.)

FIG. [illegible]. Result of [illegible] (Courtesy of Dr. Arthur B. Cecil.)

10. Small tube pedicle grafts such as are exemplified by the [illegible] method are likely to leave fistula at the base of the pedicle graft. They

have tendency not to join in the development of the penis and to cause retraction of the penis and in some instances contraction of the caliber of the tube.

11. The most successful method of reconstructing the urethra is by the method of Thiersch which is applicable to all forms of hypospadias.

12. Many cases of epispadias with incontinence are curable.

13. Transplantation of the ureters to the bowel should be reserved for those cases in which one has utterly failed to reconstruct the vesical neck,

SUBJECT INDEX